# Thomas Creek

# Restoration Project

## Soils Report

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# Introduction

This report will focus on the soil resource for the proposed Thomas Creek Restoration Project. The report will detail the specific soils mapped within the activity area, their limitations, and offer methods that may allow for mitigation of limiting characteristics for a given soil or activity unit.

This analysis will be conducted for ground disturbing activities. Depending upon erosion & sediment findings, this analysis will limit to activity areas or methods proposed.

FSM 2520 R-6 Supplement 2500-98-1 provides direction for the management of soils within activity areas. Umatilla NF (LRMP) also has the goal to plan and conduct land management activities so that reductions of soil productivity potential caused by detrimental compaction, displacement, puddling and severe burning are minimized. The goals within the LRMP state that a minimum of 80% (<20% detriment impacts) of the activity area needs to be in a condition of acceptable productivity potential.

This analysis utilizes the soil mapping from the Terrestrial Ecosystem Unit Inventory (TEUI) currently being completed on the Umatilla NF. A complete list of relevant mapping units is listed in the appendix of this document. While the TEUI for the Umatilla is unpublished, the area containing the Kalher project area had been completed previously, by the soil survey contractor.

While the soil resource does not have a direct relationship to the purpose and need of the project, there is a concern that the projects activities will influence the soil productivity and create unintended consequences to the productivity of a stand in the future. Specific to that are the following Thomas Creek Issues to be examined in this analysis:

Issue 3: Use of temporary roads and reopening of existing closed roads has the potential to increase sedimentation.

Differences in alternatives would be measured by:

1. Miles (acres) of temporary roads used and miles of system road use.
2. Miles (acres) of temporary roads before and after harvest.
3. Miles of closed system roads and temporary roads used in RHCAs

Issue 4 Mechanical Treatments in RHCA's could increase sedimentation.

Differences in alternatives would be measured by:

1. Total acres proposed for treatment within RHCA's.
2. Acres of mechanical treatments proposed within RHCA's

## Resource Indicators and Measures

The Umatilla NF LRMP has soil productivity goals that are used as indicator of change. The LRMP directs that land management projects will:

**Table 1 Resource indicators and Measures for assessing effects**

| Resource Element | Resource Indicator | Measure | Used to address: P/N, or key issue? | Source (LRMP S/G; law or policy, BMPs, etc.)? |
|---|---|---|---|---|
| Slope Stability | Landslide or other movement in proposed activity unit | Mapped area of unstable acres in proposal | No | LRMP, FSM, Multi-Use Sustainable Yield Act |
| Soil Productivity (DSC) | ≥80% acceptable productivity potential | <20% Increase in volcanic soil Bulk Density (Db) | Yes (Issue 3 & 4) | |
| | | <15% Increase in non-volcanic soil Bulk Density (Db) | | |
| | | < 50% top soil loss within 100 sq. ft. | | |
| | | Mineral soil altered from burning and charring | | |
| Soil Productivity | Erosion loss to soil productivity or change in water quality | Loss of surface soil | | |
| Water Quality | | Change in water quality | | |

# Methodology

## Remote Data – Soil Productivity (Erosion & Sediment) and Stability

First a query was done of the Terrestrial Ecosystem Unit Inventory (TEUI) soil survey data to determine the types of soils present within the planning area. These soils have been previously mapped under contract with the Blue Mountain TEUI. This mapping is inspected by the Forest Service and NRCS as it contract task orders are completed and the resulting survey is commensurate with NRCS county soil surveys. Some of the taxonomic information (texture) was used in the WEPP[1] (Elliott & Robichaud, 2001) erosion analysis; along with estimated vegetation data. The erosion analysis was conducted to determine if the proposed activities would create a risk to either soil productivity (erosion) or water quality (sediment). Analysis was done for all mapped soil textures in the project area (Loam, and Silt Loam). Lastly the TEUI is mapped to such detail that unstable locations can be eliminated, no units were altered by the stability analysis.

## Remote Data – Soil Productivity Influenced by Detrimental Soil Conditions (DSC)

To provide an understanding of soil productivity within proposed units, and how past activities may have influenced the soil resource; remote observations were made to identify legacy impacts. These observations began as remote sensing of historic aerial photos and contemporary aerial photographs. Areas with assumed presence of legacy equipment disturbance or a noticeable change to current vegetative cover; were digitally mapped. Because signs of equipment traffic were visible through the forest canopy using the contemporary base layer available in ARCGIS, this base layer image was used to digitize and map features to monitor (see Figure 1).

[1] WEPP – Water Erosion Prediction Program, an internet based erosion model.

### Field Observations – Soil Productivity (Erosion & Sediment) and Stability

Observations were made early in the project for soil stability and field examinations of these features do not conflicted with the completed soil mapping (TEUI-unpublished). No signs of instability were observed and presence of erosion tended to be associated with localized occurrences. No areas were identified as a chronic source of natural or accelerated erosion that may be a source of sediment. There were some locations where overland flow could offer sediment, but due to the gentle slopes and minor scour of the exposed soil; it is assumed that this occurrence was likely within background erosion and sediment volumes.

### Field Observations – Soil Productivity Influenced by Detrimental Soil Conditions (DSC)

The criteria for disturbed soil were defined by Page-Dumroese, et al 2009 & Napper et al 2009. The descriptions within the Soil Disturbance Protocol were then used to field validate the presence or absence of detrimental disturbance mapped from remote sensing. This field validation was conducted by a Soil Scientist. These observations helped to determine detrimental impact to the soil resource remaining in an impacted. Observations and the criteria used were adapted from Forest Soil Disturbance Monitoring Protocol Volume 1: Rapid Assessment (Page-Dumroese, et al 2009).

The presence (or absence), growth and development of trees in mapped trails was considered to be a surrogate for soil productivity. Soil disturbance observations were along mapped trails. Plot size was based on the average 12ft width of trails. Information gathered showed a presence or absence of tracks (ruts), berms or burned soil and the depth of the disturbance. The presence of ruts or berms is a sign of soil disturbing equipment traffic. When harvest activities occur at dry soil moisture, the effects from equipment can easily recover or not occur. However, if the soil is moist; detrimental conditions can appear and persist through time. To measure a change in soil structure or lost soil productivity each data collection point a hand shovel excavation to measure any change in the soil structure. Changes were and compared the soil structure of an undisturbed area.

### Information Sources

The SRI and TEUI offer the taxonomic classification of mapped soils; its parent material (Geology), general landscape position (Topography), biological factors (Vegetation), climate and age. In addition to the soil forming factors the TEUI also describes the stability of a soil, its typical depth, its texture, and its drainage.

### Incomplete and Unavailable Information

The field data for the observed detrimental effects of previous activities did not cover every unit in the proposal and therefore should be considered incomplete information. However the information gathered (remotely and actual observations) serves as an indicator of the accuracy of the remotely sensed data.

# Affected Environment

## Existing Condition (Soils)

### Natural development

Within the project area an Order 3 soil survey Terrestrial Ecosystem Unit Inventory (TEUI) has been conducted, an Order 3 survey is conducted by plotting soil boundaries and verification by traversing representative areas and some transects. These taxonomic delineations result in polygons of various shapes and sizes across the landscape. Polygons are populated with either a soil consociation (single series) or soil complexes of various soil series. The soil complexes in the soil survey used typically have up to four soil series within a complex. Commonly it is the series named first within the complex that has the dominant presence within the complex; the remaining series are named in corresponding order of dominance.

Other information derived from the soil survey is the developmental origin of a soil, from its taxonomic soil order. Within the project, four soil orders are identified by the soils mapped in proposed units. The project areas, soil orders range in their development from slight (Inceptisols & Andisols) to intermediate (Mollisols) in their degree of development (Brady & Weil. 1999). For context, soil development can range from hundreds of years to thousands depending upon the competency of the mineral parent material (geology) and the climate of the area.

As previously mentioned soil taxonomy offers a window into how the landscape may have looked long ago. For example two of the three soil orders identified can develop under a forested environment. Inceptisols are considered to be recently developed soils (Brady & Weil. 1999), and may form on the deposition of colluvium (rock fall). The series within the soil order of Inceptisols are mapped mostly in draws and other concave landforms and thus conform to the concept of Inceptisols development. Though present in the soil mapping Inceptisols do not make up any individual mapping unit complexes and are mixed in with the other soil orders in various map units. Inceptisols also make up the smallest represented soil order in the project area. Andisols are formed when there is a deposition of volcanic flow of pumice material or air fall laden ash and pumice cover other existing soils to the point that soils taxonomic characterization is changed; such as those found within the Thomas Creek area. In the Thomas Creek area it is assumed that the presence of intact over burden of ash air fall is stable since deposition and is also a sign of increased productivity (Garrison-Johnston et al, 2007), when compared to non-Andic soils.

**Table 2 Percent of Soil Orders in Proposed Activity Units by Alternative**

| Alternative | Soil Orders | | |
|---|---|---|---|
| | Andic | Mollic | Mixed[2] |
| B | 49% | 29% | 22% |
| C | 47% | 27% | 26% |
| D | 48% | 29% | 23% |
| E | 54% | 26% | 20% |

Then there is the soil order Mollisols within the project area. Mollisols typically form in a grassland environment. While some Mollisols form under forest, but mostly in depressions (Brady & Weil. 1999). What classifies these soils as Mollisol; a dark color (Chroma of 2 or less), the presence of high organic matter content, and >50% saturation with base-forming cations $Ca^{2+}$, $Mg^{2+}$, etc. (Brady & Weil. 1999). Given the landscape position of most Mollisols soils mapped in the area ridge to wide flat convex surfaces, it is not likely these soils formed under a forest in topographic depressions. Not that trees were absent in the development of these soils; but the soil habitat may have been best described as grass dominated savannah with widely spaced trees. It is not known what may have created the conditions

[2] Variations of Soil Orders mixed in mapping soil complexes: Inseptisol-Andisol-Mollisol, Mollisol-Andisol-Mollisol, Andisol-Mollisol-Mollisol, & Andisol-Andisol-Mollisol.

which formed these soils, but it is very likely that fire had a role in density management that produced the areas Mollisols.

Productivity of soil orders within the project area. Many of the soils in the proposed activity units are capped by ash (Andic deposition). This presence of andic properties did not add enough air fall ash to change the soil to an Andisol, but this ash cap needs to be recognized; it offers elevated infiltration of precipitation and water storage. When this ash cap condition is found on a Mollisol, it creates a very productive soil condition. The overburden of ash improves the moisture content of a Mollisol, thus making the nutrients inherent to the Mollisol more plant available. Plant uptake of nutrients occurs only when those nutrients are in a soluble form (Brady & Weil 1999). Therefore when we find ash capped Mollisols this soil is likely to be the most productive and have the greatest soil resiliency in the project area with respect to the proposed activities. This is not to say that this resilience can't be undone by forest activities conducted without proper Best Management Practices (BMPs)

## Human Influences to the Soil Resource

As mentioned in Methodology (Field Observations), there have been human caused influences that caused some change to the soil resource and its resilience. Some of these influences have been recognized as having either beneficial, no effect, or detrimental effects to the soil resource.

In the past, human ignited fire could be partially responsible for stand densities consistent with Mollisol soil development. In a general sense, it is assumed that maintenance burning will beneficially consume fuels, preventing the high intensity/long duration fire that can detrimentally heat alter the soil resource. Conversely, current human suppression of fire helps to build wildland fuel loads that may create detrimental effects to the soil resource (i.e. heat altered soil). Heat altered soil is commonly associated with sterilization of the topsoil and the formation of hydrophobic layers that promote erosion and stream sediment. Erosion form a site may cause the loss of plant available soil nutrients and Soil Organic Matter (SOM). Noted by the numerous authors, the Natural Resource Conservation Service (NRCS) promotes the concept that 1% SOM increase in a ½ acre foot of soil will afford 27,000 gallons of plant available water. So we can also assume the inverse; a loss of 1% of SOM from that same ½ acre foot of soil will represent a loss of 27,000 gallons of potential water storage from that same acre.

Concentrated human activity on native surfaces can create effects seen as roads and trails. The most direct and recognizable influence left on the landscape is either from past harvest activity or unregulated recreation activities in the form of soil compaction and soil displacement. It has been noted by numerous authors that compaction and displacement effects associated with temporary roads and skid trail equipment traffic can detrimentally influence vegetation and their associated soil communities (Froehlich & McNabb1983, Amaranthus et al, 1996, Bulmer et al, 2010 and Miller 2004). Often, impacts like temporary roads landings & trails do not prevent vegetation from growing seedlings, but these features can limit the opportunity of vegetation to reach maturity. Additionally if left on the landscape without Effective Ground Cover (EGC) these features can cause erosion (Lane et. al. 1988). Depending upon the impacts proximity to surface water, they could serve as sediment sources. At this time there are no observed sources of direct sediment input within the project area.

### *Erosion and Sediment*

Baseline overland erosion and the sediment it may create were modeled with WEPP, for slopes and soil textures found within proposed harvest units. This modeling also took into account the differing soil textures & rock percent's associated dominant soils in all units; unit slopes ranges, and the EGC were also part of the variables in the modeling. To generate baseline sediment and the probability of its occurrence, the range of variables in units were populated in the model to test the greatest distance offered within the model (1200ft). This modeling showed a baseline that was low probability (0%) of sediment and low volumes of sediment (undetectable). Since this is a model and may not represent actual occurrences, the nearby Barometer Watershed report (Helvey and Fowler 1995) was used to define baseline estimates to be used with the modeled results. The modeled results are for sediment; this soils analysis assumes that modeled estimates above 0.03t/ac (Helvey and Fowler 1995) will need some mitigation or avoidance measures to allow for proposed activates to be considered sustainable from the perspective of the soil resource.

### Resource Indicator or Measure 1

Observations were made early in the project for soil stability and field examinations for these features do not conflicted with completed soil mapping (TEUI) and or add to known landslide features mapped on the Umatilla NF. Therefore this resource indicator of slope stability is not a factor in this analysis.

### Resource Indicator and Measure 2

Presence of erosion was detectable, but field observations are consistent with expected sedimentation rates noted by WEPP and Helvey and Fowler 1995.

### Resource Indicator and Measure 3

Evidence of scour (sediment movement was recorded in the examination of streams (i.e. Class 4 identification). However it is assumed that field observations are consistent with expected sedimentation rates noted by WEPP and (0.03t/ac) Helvey and Fowler 1995.

### Resource Indicator and Measure 4

The presence of DSC was found in association with legacy trails. It is assumed that most of these trails were left from previous harvest activities, but some may have been created from unregulated recreation in the area. Topography of the area is conducive to access for most forms of vehicles used in recreation activities. Estimates of DSC are based on the 2013 Thomas Creek field observations; in those site visits 98200ft of trails were examined; 31% was considered to be in DSC, when using the criteria from Page-Dumroese, et al (2009).

## Management Direction

### Desired Condition - Multi-Use Sustainable Yield Act, FSM and LRMP

Multi-Use Sustained Yield Act of 1960, directs the agency to manage resources (outdoor recreation, range, timber watershed and fish) in combination that best meets the needs of the American people. Sustained yield means achieving and maintaining into perpetuity a high-level annual or regular periodic output of renewable resources without impairment of the productivity of the land.

Forest Service Manual (FSM) 2500 has the objective (FSM 2551.02) to determine if land management practices need adjustments to sustain or restore soil quality.

Figure 1 is intended to illustrate the relationship between soil quality indicators, soil function and soil productivity. Soil quality indicators are developed to give insights as to how well the inherent soil is functioning, i.e., biologically, hydrological, carbon storage, etc.

The FSM 2551.5 further states that the use of soil quality indicators ultimate goal is to provide information on the health of the soil. For example; when an indicator (i.e. tree growth), is altered by management practices. This type of alteration to soil indicators is considered an expression of a detrimental change to the productivity of the soil resource.

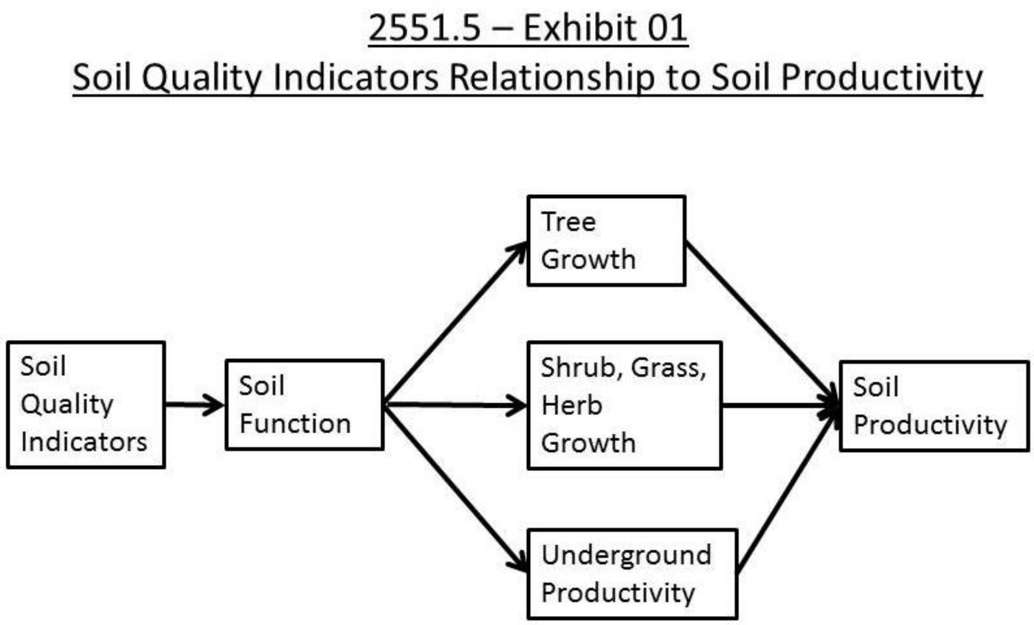


**Figure 1, Flow chart copied from FSM 2550 page 16 of 20.**

The Desired Future Condition in the 1990 Forest Plan (LRMP) for water/soil is to maintain soil productivity (Forest Plan p. 4-9). The plan states that Standards and Guidelines are to maintain a minimum of 80 percent of an activity area in a condition of acceptable productivity potential. Acceptable productivity in the 1990 LRMP is defined as:

- Less than 20% increase in bulk density of volcanic soil or a less than 15 percent increase in soil bulk density for other forest soils.
- Soil disturbance of less than 50 percent of the topsoil humus enriched A1 and or AC horizons from an area 100 sq. ft. (i.e. 5ft by 20ft)
    - Molding of the soil in vehicle tracks that area rutted to a depth less than 6 inches.
- Severely burned soil with the top layer of mineral soil altered in color (usually to red) and the next ½ inch blackened from organic matter charring.
- Plan and conduct land management activities so that soil loss from surface erosion and mass wasting, caused by activities will not result in an unacceptable reduction in soil productivity or water quality.
- Management activities shall be designed and implemented to retain sufficient ground vegetation and organic matter to maintain long-term soil and site productivity.
- Active slump and landslide area are considered unavailable for road construction. Areas with known landslide potential and lake sediments require special transportation planning and design, layout preconstruction, construction and maintenance techniques.

# Environmental Consequences

## Alternative A – No Action

### Direct and Indirect Effects

**Table 3 Resource Indicators and Measures (RIM) for Alternative A.**

| Resource Element | Resource Indicator | Measure | Miles | Acres |
|---|---|---|---|---|
| 1. Soil Stability | Soil Mass Wasting | No active areas identified | 0.0 | 0.0 |
| 2. Soil Productivity | Erosion | Activity unit acres modeled >0.03t/ac | 0.0 | 0 |
| 3. Water quantity | Sediment | Activity units that may produce >0.03t/ac | 0.0 | 0 |
| 4. Detrimental Soil Conditions (DSC) | Change or absence in vegetation growth | Total Disturbance | 23 | 33 |
| | | Assumed DSC within planning area | 7 | 10 |

### Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement did not influence the proposed alternative in the recent past, nor will it play a role in this alternative or the foreseeable future.

### Resource Indicator and Measure 2

If the project area were to continue unchanged by further disturbance from humans or natural events; it would remain on its current soil developmental trajectory with no direct change to the resource indicator of erosion. Table 2 offers the percent of soil orders mapped within proposed units, in Figure 2 we see a distribution of these soil orders in the planning area. This offers an indication as to where some soils (Mollisols) have transitioned in development from grass dominated conditions to forest dominated vegetation. In Figure 2 the green areas are the Mollisols, which potentially developed under grasses. The Andic and mixed soil orders are tan and red respectively.

Regardless of the lack of action in this alternative, there are signs of legacy trials assumed to be detrimentally impacted from previous harvest. While the presence of some DSC is known to increase sediment, it is currently covered with adequate EGC to limit erosion above background levels.

Due to the presence if DSC (legacy trails) erosion could have be indirect effect to this alternative. Indirect effects would occur with the loss of EGC from disturbance (wildfire). This alternative does not reduce fuel loads, thus the wildland fire assumptions in the alternative are for High Severity Burn.

Assumptions for the WEPP runs included 30 year climate model duration, loam and silt loam soil textures, slope gradients from 10 to 60 percent, upper slope lengths of (1200ft – harvest), and (300ft to 700ft skid trails), and with cover elements of Mature Forest (100% cover), and High Severity Fire (45% cover). Additionally the cover element of skid trials was added due to the presence of existing skid trails in the proposed units; skid trails in WEPP was a cover of 10%, with a contestant surface rock content of 10%. Lower slopes (buffers) were modeled with gradients of 10 to 60 percent, lengths of 5 to 95 feet, with no treatments (Mature Forest 100%). To model the effects of wildfire buffer covers were reduced to

45% (WEPP default for High Severity Fire), soil cover of 100 percent, rock content 10 percent. Background (no action) runs were also made; with upper elements having the same variable as the lower elements to model current erosion and sediment. The inputs for each of the model runs, is listed in the appendix of this soils report.

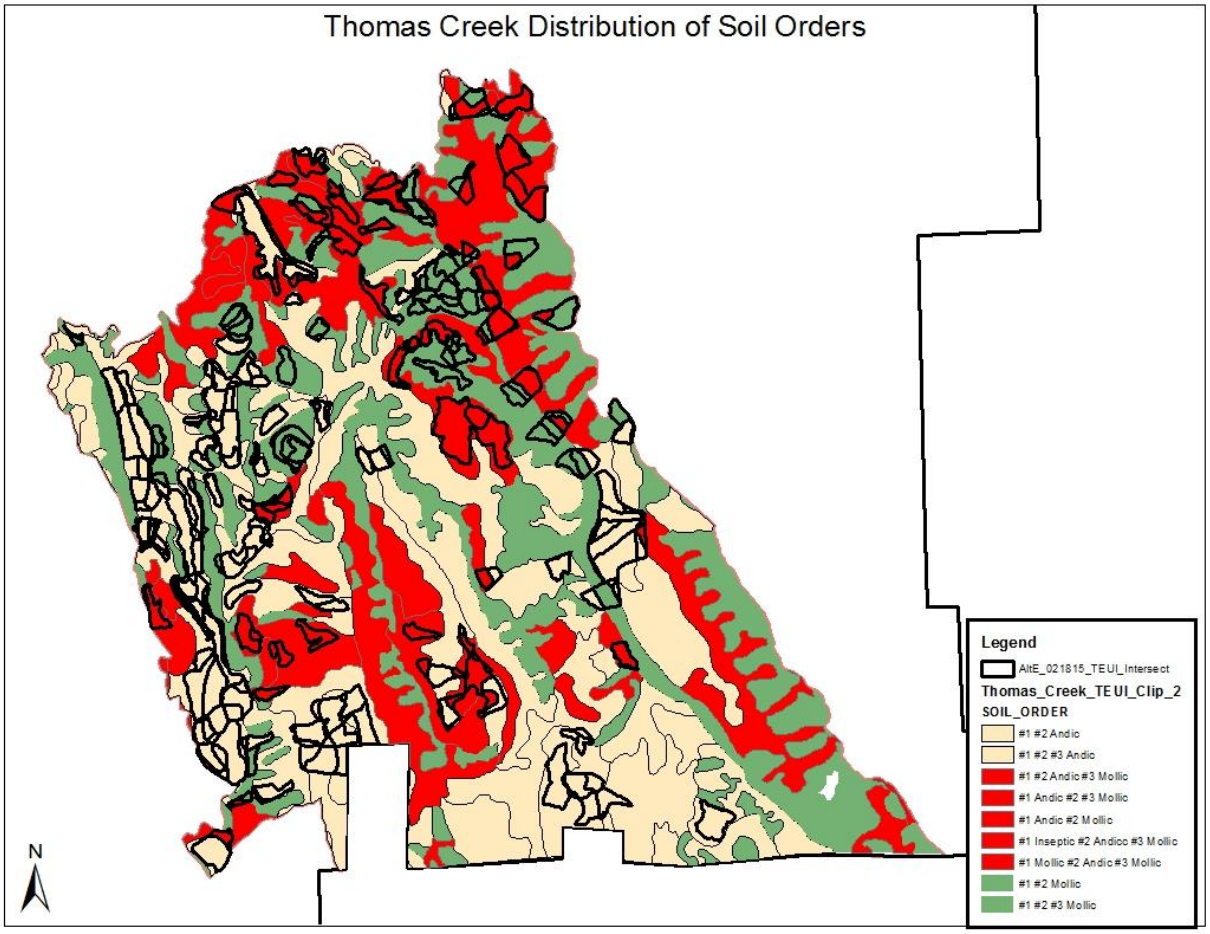


**Figure 2 Distribution of soil orders across Thomas Creek project area**

The most productive part of the soil is often the closest to the mineral surface (Brady & Weil 1999). Erosion would either change the location of productive soil; or be a loss of soil productivity to stream sediment inputs. Additionally, it is assume that the network of legacy trails can offer means to route surface flow and sediment to streams. In an effort to understand this effect WEPP modeling added the variable of EGC loss in the harvest scenarios modeled. As with the no action alterative showed previously; just the removal of tree canopy did not have an effect to erosion.

Further modeling in the proposed activities added the potential of wildfire and DSC. This was an attempt to examine the occurrence of wildfire in all alternatives for comparison. The WEPP model inputs used first examined reflected the flattest sloped buffer; 10% slope between the trail end and stream. In the non-wildfire scenarios this condition was the least impactful model run. Loss of cover (10% trail cover) was used in the model and 45% cover (High Severity Fire) default, was used for wildfire effects in the buffer. In the modeling with low Effective Ground Cover (EGC) from wildfire; we see that a skid trails closer than 400ft of streams, could input sediment into streams. This illustrates the importance of EGC within no equipment riparian buffers.

## Resource Indicator and Measure 3

If the project area were to continue unchanged by further disturbance from humans or natural events; it would remain on its current soil developmental trajectory with no direct change to the resource indicator of sediment. This assessment is made despite the presence of DSC in the form of legacy trials assumed to be detrimentally impacted from previous harvest. While the presence of some DSC is known to increase sediment, it is currently covered with adequate EGC to limit sediment above background levels.

Further modeling in the proposed activities added the potential of wildfire and DSC. The WEPP model inputs used first reflected the flattest sloped buffer; 10% slope between the trail end and stream. In the non-wildfire scenarios this condition was the least impactful model run. Total loss of cover in the model run assumed, 10% trail cover and 45% High Severity Fire default in WEPP was used for the buffer.

## Resource Indicator and Measure 4

Without human intervention there are not many cases when the soil resource can be influenced. Thus the inhibition of the growth of tree and brush (FSM 2551.5 exhibit 01) would be considered an expression of a detrimental change to the productivity of the soil resource. Within the proposed planning area there are human created trails that measure approximately 33 miles of assumed trail. These trails have appeared to have inhibited vegetation growth and type of growth. To verify this change the Soil Disturbance Monitoring Protocol was adapted to evaluate the recognized changes (Page-Dumroese, 2009).

The inhibition on plant growth seems to be related to trees and brush; grasses, herbs and forbs in general may also have been influenced, but no measureable change was identified in the soils report. Estimates of DSC (Table 3) are based on field observations (Table 13). The effects appear to be consistent to those made in the Kahler project, where 31% of the observed impacts were considered to be in DSC, using criteria from Page-Dumroese, et al (2009). That impact was used to evaluate potential impacts in units. When mapped trails in Thomas Creek were clipped to existing unit boundaries, 31% of clipped trails were calculated as DSC. Using these criteria Alternative A as a whole or any of its individual units exceed DSC under the forest plan.

## Cumulative Effects

### *Spatial and Temporal Context for Effects Analysis*

Cumulative effects are not expected from Resource Indicator and Measure (RIM) 1 – Mass movement.

Cumulative effects from RIM 2 – Erosion, are expected to be localized; unless influenced by a combination of wildfire and the erosion processes exposed to high winds. Winds can transport detached soil aloft and to a new location. This would prove to be a loss to soil productivity within a proposed unit, if this occurs it is unknown if some portion of this material would end up as sediment. The potential duration of expected erosion risk would be for at least 3 years immediately following wildfire (Elliott et al 2001 and Robichaud 2000). The volumes of erosion under this risk are also influenced by the intensity and duration of precipitation events that occur during elevated erosion risk.

Cumulative effects from RIM 3 – Sediment, are expected to be small with no elevation above assumed background levels; unless like above influenced by wildfire. If wildfire takes place elevated. The potential duration of expected sediment risk would be for at least 3 years immediately following wildfire (Elliott et al 2001 and Robichaud 2000). The volumes of sediment under this risk are also influenced by the intensity and duration of precipitation events that occur during elevated sediment risk.

Cumulative effects from RIM 4 – Detrimental Soil Conditions (DSC) that assumed to be created by equipment traffic seem to be long-lived (>40 years). While there may be some surface recovery (<4in) of soils freeze over winter, this benefit is only near the surface and deep compaction persists.

#### *Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis*

All ground disturbing activities included in the list of past, present and reasonably foreseeable activities for the Thomas Creek project in the EA (Chapter 3) are relevant to cumulative effects analysis for DSC.

## Alternative B – Proposed Action

### Project Design Features and Mitigation Measures

Per Multi-Use Sustainable Yield Act, FSM and LRMP the following design features and mitigations will be placed on Alternative B.

1. Use of harvest equipment will not be permitted when soils reach field capacity for moisture, to limit the potential of long-term detrimental soil disturbance (Amaranthus et al. 1996, Bulmer et al. 2010, Froehlich et al. 1983, Heninger et al, 2002, Miller et al. 2004 and Page-Dumroese et al 2009.)

2. Placement of new temporary roads will be on deep soils, if it is operationally feasible. This will allow for adequate restoration of temporary roads and over time will leave less measurable detrimental soil condition across the proposed activity units (Archuleta, 2006, 2007, 2008). Lithosol (scab flats) and meadows will not be used for landings and skid trails; unless no other location is practical. If use is necessary disturbance will be kept to a minimum amount of the area, preferably at the edges of these features.

3. Within commercial harvest units, no harvest or heavy equipment will leave designated roads or trails, to limit the potential of detrimental soil disturbance. In the non-commercial thinning units, mechanical thinning equipment may be used provided that equipment that exceeds 7 PSI is not allowed to travel over the same path more than once. Some noncommercial thinning will be by sawyers (hand only).

4. In areas of harvest within the RHCA, no equipment or scour from skyline corridors will be allowed within either 75 or 100 feet of the water; depending upon RHCA slopes. In the WEPP modeling it was determined that these no equipment buffers are needed to limit scour from the repeated activities of ground based or skyline activities. To implement this design feature see Table 11 for criteria and distances.

A full list of BMPs, some with criteria driven by soil resource concerns have been incorporated within the EIS.

### Direct and Indirect Effects

### Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the proposed alternative in the recent past, nor will it play a role in this alternative or the foreseeable future.

**Table 4 Resource Indicators and Measures (RIM) for Alternative B**

| Resource Element | Resource Indicator | Measure | Miles | Acres |
|---|---|---|---|---|
| 1. Soil Stability | Soil Mass Wasting | No active areas identified | 0.0 | 0.0 |
| 2. Soil Productivity | Erosion | Activity unit acres modeled >0.03t/ac | 0.0 | 0 |
| 3. Water quantity | Sediment | Activity units that may produce >0.03t/ac | 0.0 | 0 |
| 4. Detrimental Soil Conditions (DSC) | Change or absence in vegetation growth | Total Disturbance | 8 | 11 |
| | | Assumed DSC within planning area (31% of impacted area) | 2 | 4 |

## Resource Indicator and Measure 2

In Alternative B that will have some effect on Soil Productivity (Erosion): harvest (Ground Based, Skyline, Helicopter and Prescribed Burning). Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence erosion. Additionally there will be some Non Commercial Thinning (NCT) proposed. It is not expected that this activity will have a detrimental effect to the soils.

As mentioned in the existing condition discussion, there are existing DSC within activity areas from past activity. Some of the proposed activity impacts (Alt 2) will overlap with proposed temporary roads. During the implementation of activates, there will be some elevation of risk to erosion. However BMPs (erosion control) will mitigate or diminish; if not all most of the short term effects from erosion. To estimate this risk the WEPP model was used.

While the WEPP modeling did not take slope profiles to input into the model, a range of slope characteristics were identified in GIS that cover the range of slope conditions found within the proposed units. WEPP uses two elements in the model. The upper element represents the disturbance activity (i.e. harvest), and a low element which represents the sediment buffer to a waterway. In the model the steepest slopes found in the units were used to represent the worst case scenario for erosion modeling (upper element 60%, lower element 40% to 60%). To display differences in effect to the RHCA treatments, a variety of buffer widths were used in the model (Table 12).

Results of the model runs for harvest and burning treatments showed that average annual erosion was very low (0.0044t/ac). The harvest example was using no disturbance other than removal of EGC. This is not to say under the extreme conditions (high precipitation, poor EGC left in place, or unplanned equipment traffic), erosion could not occur above background levels.

Based on the model runs and assumed background levels, it was decided that the harvest and prescribed burning would produce less sediment delivery than a high severity wildfire of similar size, so the Thomas Creek harvest and burning in RHCA would be justified and no soils specific Design Criteria is recommended based on canopy removal.

When the WEPP model used the criteria to examine skid trails there was elevated erosion, so design criteria was developed. This information was used to limit the length of trails (225ft and 600ft); acceptable skidding lengths are based on slope breaks and are defined in the Design Criteria of this EIS (Table 11).

The previously mentioned trails that will be used in the proposed activity as temporary roads will be subject to restoration (obliteration) of the DSC. As long as the proposed activity is allowed to use legacy trails, they can be eliminated by contract provision of a timber sales.

## Resource Indicator and Measure 3

In Alternative B there will be some effect to the Resource element of Water Quality (Sediment). In unit 94 there is a presence of an aquic soil (Balloontree Series), poorly drained soil mapped in a TEUI complex. This instance of Balloontree series is mapped along the northern edge of the unit and is associated with FS road 3100-284. However with appropriate road BMPs in place this condition is not expected to limit activities within the unit. Mentioned in the existing condition discussion there is existing DSC from past activities. Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence sediment. Some of the proposed activity impacts will overlap with proposed temporary roads. During the implementation of activates, there will be some elevation of risk to erosion. However BMPs (sediment) will mitigate or diminish; most if not all, short term effects from erosion. To estimate this sediment risk the WEPP model was used the two soil textures of loam and silt loam are the only soil textures that were mapped within the proposed units.

Results of the model runs for harvest and burning treatments showed that average annual sediment was below background, <0.03t/ac (Helvey and Fowler 1995). This means that harvest of trees (in or out of the RHCA), to the prescribed canopy density (>40% cover); would not show a measureable effect from sediment. This is not to say all proposed activities (in or out of the RHCA) would not have an effect to sediment (Table 12). Since skid trails are often extremely deficient of EGC, additional modeling was done to examine skid trails. Skid trails (a yarding method) are the one example when sediment could rise above background levels. A cover of 10% (skid trails) was used in WEPP model runs (Table 12). When skidding of trees was examined in relationship to the RHCA thinning, unlike the felling of trees; it was determined that a buffer was indeed needed to minimize the risk of sediment to streams.

Using the WEPP model runs and assumed background levels, it was assumed that the harvest and prescribed burning would produce less sediment delivery than a high severity wildfire of similar size. The analysis thereby shows that the Thomas Creek harvest and burning in RHCA would be justified and no Design Criteria is recommended based on canopy removal. Skid trails do a have design criteria based on skid trail length and percent of slope in RHCA treatments (Table 11). This design criterion offers two options for equipment use near streams no closer than 75ft or no closer than 100ftt from a stream, based on topographic and transportation needs. With all other streams the normal buffer distances will still apply, for both harvest and equipment traffic.

Some benefits to the sediment are expected from this alternative. As previously mentioned there are existing legacy trails. Some of these trails will be used as temporary roads in the project and subject to removal per the forest plan. Additionally since the temporary roads are used in the timber sale itself, it is allowable that under contract provisions of the timber sale they can be obliterated. These obliterated roads are considered restoration of the soil resource; in the event of a wildfire or similar defoliating event, the obliterated road will not offer a means of sediment inputs.

## Resource Indicator and Measure 4

In Alternative B there will be some effect to Detrimental Soil Conditions (DSC). Mentioned in the existing condition discussion there is existing DSC from past activities. Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence sediment.

While Reeves offers a comprehensive list of expected detrimental effects, it appears these estimates may underestimate effects if certain conditions are present or absent. To offer an expected DSC that may be relevant to proposed activities and conditions present the following were used in DSC calculations; Ground Based 10% (Archuleta, 1997 & 1999), Skyline 5%, Helicopter 1% (Siskiyou NF, 1997), Prescribed Burning 1% (Bennett, 1982). Additionally, there may be some use of ground based equipment to pre-bunch helicopter loads to improve efficiency of helicopter logging. This activity will be done with a single pass to limit DSC described by Han (2006); the soil moisture for this activity will also be limited to dry conditions as a further mitigation.

Understanding the benefiting opportunities from fuel loading (slash) with yarding method may be an important factor to consider in the analysis. If harvest in a unit occurs before or as it transitions from moist to dry soil conditions; equipment may need to ride on slash to minimize DSC.

To illustrate how important this may be to the Thomas Creek project, Figure 3 is offered as an example. In this harvest on the Umpqua NF (Flat IRTC)[3]; this depiction shows how intensive traffic may be for some ground based yarding equipment. Slash was available for both yarding methods to use as mitigation to equipment weight and soil disturbance. In the Flat IRTC project the harvester (Harvester/Forwarder) used slash to minimize soil disturbance. The actual trails marked within the harvester section do not represent all trails used. The map only represents those trails needing to be obliterated by the harvest contractor in that Stewardship project. There were "ghost trails" which registered no DSC disturbance (between mapped trails) used in the harvester section. These unmapped trails used a slash mats (>1 foot) to float equipment; leaving no measureable detrimental effects in their wake. Another reason for the low disturbance was trail spacing was around 80 to 100ft apart; the trees being harvested from "ghost trails" were directional felled to the mapped trails from unmapped trails. This allowed for the "ghost trail" to be used once in a single direction, effectively making a single pass and limiting DSC effects (Han, 2006). To operate effectively skidders normally clears its trail, traveling mostly on the mineral soil; creating Detrimental Soil Conditions (DSC) like compaction, rutting and displacement of topsoil (LRMP 1990 and Bustos and Egan 2011).

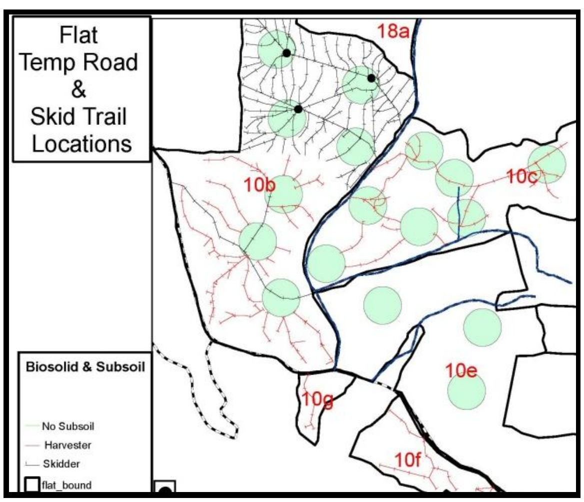


**Figure 3 Cropped map of Flat IRTC monitoring. Umpqua NF, 2009.**

Though it shows an example from western Oregon, the comparison of yarding methods in Figure 3 is important for the Thomas Creek analysis. It is assumed that the opportunity to mitigate equipment disturbance with slash is an option in many Thomas Creek project units. Therefore if harvester/forwarder

[3] Impacts were GPS located and later subsoiled to restore acceptable soil productivity to the entire unit

yarding is used during implementation the weight and disturbance of this yarding method can buffer the soil from disturbances. If this skidders are used the resulting effect will likely be similar to the skidder disturbance seen in Figure 3.

Within the proposed planning area there are human created trails that measure approximately 23 miles of assumed trail. Some of these trails have appeared to have inhibited vegetation growth and type of plants. To verify this change the Soil Disturbance Monitoring Protocol was adapted to evaluate the recognized changes (Page-Dumroese, 2009).

The inhibition on plant growth seems to be related to trees and brush; grasses, herbs and forbs in general may also have been influenced, but no measureable change was identified in the soils report. Estimates of DSC (Table 4) are based on field observations (Table 14); the effects appear to be similar to those made in the Kahler project. Within Kahler 31% of the observed impacts was considered to be in DSC, when using the criteria from Page-Dumroese, et al (2009). That impact was used to evaluate potential impacts in units. When mapped trails in Thomas Creek were clipped to existing unit boundaries, 31% of clipped trails were calculated as DSC. Using this method it was determined that 3% DSC was the greatest DSC finding in a given unit.

Therefore within the harvest units there is a total of 8 miles (11acres) of trail for a total of DSC (including system roads). Since only 31% of the evaluated impacts were deemed to be DSC; like alternative A, we can assume 31% of the total DSC is a loss to the soil resource (2 miles or 4 acres).

Of the legacy trails mapped in the project area, some measure of these trails/roads will be obliterated. Actual mileage of obliteration is dependent upon the amount of temporary road and legacy DSC overlap.

Further modeling of the proposed activities added the potential of lost EGC from wildfire and DSC for alternative A. The same model inputs were used in WEPP the Wildfire Scenario used in Alternative B, with the assumption that the proposed action would reduce the fire risk, so a Low Severity Fire was modeled (85% cover). In the modeling we see sediment prone acres that may offer input to streams; similar to those created by the proposed activities (Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the proposed alternative in the recent past, nor will it play a role in this alternative or the foreseeable future.

Table 4). This modeling indicates; after the project is implemented, the assumed effects of wildfire would not be as intense and thus produce unmeasurable effects from the proposal and its required mitigations.

Provided all mitigating factors are present when proposed activity occurs, the anticipated DSC for a given unit or the proposal (as a whole) does not exceed 20% DSC criteria (LRMP).

## Cumulative Effects

### *Spatial and Temporal Context for Effects Analysis*

## Cumulative effects are not expected from Resource Indicator and Measure (RIM) 1 – Mass movement, (Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the proposed alternative in the recent past, nor will it play a role in this alternative or the foreseeable future.

Table 4).

Cumulative effects from RIM 2 – Erosion, are expected to be localized; unless influenced by a combination of wildfire and the erosion processes exposed to high winds. Winds can transport detached soil aloft and to a new location. This would prove to be a loss to soil productivity within a proposed unit, if this occurs it is unknown if some portion of this material would end up as sediment. The potential duration of expected erosion risk would be for at least 3 years immediately following wildfire (Elliott et al 2001 and Robichaud 2000). The volumes of erosion under this risk are also influenced by the intensity and duration of precipitation events that occur during elevated erosion risk.

Cumulative effects from RIM 3 – Sediment, are expected to be small with no elevation above assumed background levels (Helvey and Fowler 1995) with the described mitigations and BMPs; unless like above influenced by wildfire. If wildfire takes place elevated. The potential duration of expected sediment risk would be for at least 3 years immediately following wildfire (Elliott et al 2001 and Robichaud 2000), assuming for a low severity wildfire and the reduced fuel loads.

#### *Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis*

All ground disturbing activities included in the list of past, present and reasonably foreseeable activities for the Thomas Creek project in the EA (Chapter 3) are relevant to cumulative effects analysis for DSC.

## Alternative C – Preferred Alternative

### Project Design Features and Mitigation Measures

Per Multi-Use Sustainable Yield Act, FSM and LRMP the following design features and mitigations will be placed on Alternative C.

1. Use of harvest equipment will not be permitted when soils reach field capacity for moisture, to limit the potential of long-term detrimental soil disturbance (Amaranthus et al. 1996, Bulmer et al. 2010, Froehlich et al. 1983, Heninger et al, 2002, Miller et al. 2004 and Page-Dumroese et al 2009.)

2. Placement of new temporary roads will be on deep soils, if it is operationally feasible. This will allow for adequate restoration of temporary roads and over time will leave less measurable detrimental soil condition across the proposed activity units (Archuleta, 2006, 2007, 2008). Lithosol (scab flats) and meadows will not be used for landings and skid trails; unless no other location is practical. If use is necessary disturbance will be kept to a minimum amount of the area, preferably at the edges of these features.

3. Within commercial harvest units, no harvest or heavy equipment will leave designated roads or trails, to limit the potential of detrimental soil disturbance. In the non-commercial thinning units, mechanical thinning equipment may be used provided that equipment that exceeds 7 PSI is not allowed to travel over the same path more than once. Some noncommercial thinning will be by sawyers (hand only).

4. In areas of harvest within the RHCA, no equipment or scour from skyline corridors will be allowed within either 75 or 100 feet of the water; depending upon RHCA slopes. In the WEPP modeling it was determined that these no equipment buffers are needed to limit scour from the repeated activities of ground based or skyline activities. To implement this design feature see Table 11 for criteria and distances.

A full list of BMPs, some with criteria driven by soil resource concerns have been incorporated within the EIS.

## Direct and Indirect Effects

### Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the alternative C in the recent past, nor will it play a role in this alternative or the foreseeable future.

**Table 5 Resource Indicators and Measures (RIM) for Alternative C**

| Resource Element | Resource Indicator | Measure | Miles | Acres |
|---|---|---|---|---|
| 1. Soil Stability | Soil Mass Wasting | No active areas identified | 0.0 | 0.0 |
| 2. Soil Productivity | Erosion | Activity unit acres modeled >0.03t/ac | 0.0 | 0 |
| 3. Water quantity | Sediment | Activity units that may produce >0.03t/ac | 0.0 | 0 |
| 4. Detrimental Soil Conditions (DSC) | Change or absence in vegetation growth | Total Disturbance | 9 | 13 |
| | | Assumed DSC within planning area (31% of impacted area) | 3 | 4 |

### Resource Indicator and Measure 2

Similar to the previous alternative; this alternative C will have some effect on Soil Productivity (Erosion): harvest (Ground Based, Skyline, Helicopter and Prescribed Burning). Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence erosion. Additionally there will be some Non Commercial Thinning (NCT) proposed. I t is not expected that this activity will have a Detrimental effect to the soils.

As mentioned in the existing condition discussion, there are existing DSC within activity areas from past activity. Some of the proposed activity impacts (Alt 3) will overlap with proposed temporary roads. During the implementation of activates, there will be some elevation of risk to erosion. However BMPs (erosion control) will mitigate or diminish; if not all most of the short term effects from erosion. To estimate this risk the WEPP model was used.

While the WEPP modeling did not take on the ground slope profiles to input into the model, a range of slope characteristics were identified in GIS that cover the range of slope conditions found within the proposed units. WEPP uses two elements in the model. The upper element represents the disturbance activity (i.e. harvest), and a low element which represents the sediment buffer to a waterway. In the model the steepest slopes found in the units were used to represent the worst case scenario for erosion modeling (upper element 60%, lower element 40% to 60%). To display differences in effect to the RHCA treatments, a variety of buffer widths were used in the model (Table 12).

Results of the model runs for harvest and burning treatments showed that average annual erosion was the same as alternative C. The harvest example was using no disturbance other than removal of EGC. This is not to say under the extreme conditions (high precipitation, poor EGC left in place, or unplanned equipment traffic), erosion could not occur above background levels.

Based on the model runs and assumed background levels, it was determined that the harvest and prescribed burning would produce less sediment delivery than a high severity wildfire of similar size, so the Thomas Creek harvest and burning in RHCA would be justified and no soils specific Design Criteria is recommended based on canopy removal.

When the WEPP model used the criteria to examine skid trails there was elevated erosion, so design criteria was developed. This information was used to limit the length of trails (225ft and 600ft); acceptable skidding lengths are based on slope breaks and are defined in the Design Criteria of this EIS (Table 12).

The previously mentioned trails that will be used in the proposed activity as temporary roads will be subject to restoration (obliteration) of the DSC. As long as the proposed activity is allowed to use legacy trails, they can be eliminated by contract provision of a timber sales.

### Resource Indicator and Measure 3

In alternative C there is potential to effect to the Resource element of Water Quality (Sediment). In unit 94 there is a presence of an aquic soil (Balloontree Series), poorly drained soil mapped in a TEUI complex. This instance of Balloontree series is mapped along the northern edge of the unit and is associated with FS road 3100-284. However with appropriate road BMPs in place this condition is not expected to limit activities within the unit. Mentioned in the existing condition discussion there is existing DSC from past activities. Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence sediment. Some of the proposed activity impacts will overlap with proposed temporary roads. During the implementation of activates, there will be some elevation of risk to erosion. However BMPs (sediment) will mitigate or diminish; most if not all, short term effects from erosion. To estimate this sediment risk the WEPP model was used the two soil textures of loam and silt loam are the only soil textures that were mapped within the proposed units.

Results of the model runs for harvest and burning treatments showed that average annual sediment was below background, <0.03t/ac (Helvey and Fowler 1995). This means that harvest of trees (in or out of the RHCA), to the prescribed canopy density (>40% cover); would not show a measureable effect from sediment. This is not to say all proposed activities (in or out of the RHCA) would not have an effect to sediment (Table 12). Since skid trails are often extremely deficient of EGC, additional modeling was done to examine skid trails. Skid trails (a yarding method) are the one example when sediment could rise above background levels. A cover of 10% (skid trails) was used in WEPP model runs (Table 12). When skidding of trees was examined in relationship to the RHCA thinning, unlike the felling of trees; it was determined that a buffer was indeed needed to minimize the risk of sediment to streams.

Using the WEPP  model runs and assumed background levels, it was assumed that the harvest and prescribed burning would produce less sediment delivery than a high severity wildfire of similar size. The analysis thereby shows that the Thomas Creek harvest and burning in RHCA would be justified and no Design Criteria is recommended based on canopy removal. Skid trails however may not be allowed to get closer than 75ft from a stream in RHCA treatments; in cases of increased slopes that buffer can be 100ft (Table 11). With all other streams the normal buffer distances will still apply, for both harvest and equipment traffic.

Some benefits to the sediment are expected from this alternative. As previously mentioned there are existing legacy trails. Some of these trails will be used as temporary roads in the project and subject to removal per the forest plan. Additionally since the temporary roads are used in the timber sale itself, it is allowable that under contract provisions of the timber sale they can be obliterated. These obliterated roads are considered restoration of the soil resource; in the event of a wildfire or similar defoliating event, the obliterated road will not offer a means of sediment inputs.

## Resource Indicator and Measure 4

In alternative C there will be some effect to Detrimental Soil Conditions (DSC). Mentioned in the existing condition discussion there is existing DSC from past activities. Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence sediment.

While Reeves offers a comprehensive list of expected detrimental effects, it appears these estimates may underestimate effects if certain conditions are present or absent. To offer an expected DSC that may be relevant to proposed activities and conditions present the following were used in DSC calculations; Ground Based 10% (Archuleta, 1997 & 1999), Skyline 5%, Helicopter (Siskiyou NF, 1997), Prescribed Burning (Bennett, 1982). Additionally, there may be some use of ground based equipment to pre-bunch helicopter loads to improve efficiency of helicopter logging. This activity will be done with a single pass to limit DSC described by Han (2006); the soil moisture for this activity will also be limited to dry conditions as a further mitigation.

In the same way Alternative B described mitigation of DSC with slash Alternative will also rely on slash to minimize DSC with some ground based methods. The comparison in Figure 3 is important for the Thomas Creek analysis; it is assumed that the opportunity to mitigate equipment disturbance with slash may not be an option in many Thomas Creek project units. Therefore if harvester logging is used during implementation; it must occur after the soil has transitioned from moist to dry soil conditions. If this design criterion is not followed, the resulting effect will likely be similar to the skidder disturbance seen in Figure 3.

The elements of DSC are currently present in proposed units and will change in some areas by proposed activities. This change will take place mostly in association with the overlap of legacy trails and new temporary roads. Where this overlap occurs it is expected that there will an overall decrease in DSC for that segment of legacy trail. Within the proposed planning area there are human created trails that measure approximately 23 miles of assumed trail.

The inhibition on plant growth seems to be related to trees and brush; grasses, herbs and forbs in general may also have been influenced, but no measureable change was identified in the soils report. Estimates of DSC (Table 4) are based on field observations (Table 14); the effects appear to be similar to those made in the Kahler project. Within Kahler 31% of the observed impacts was considered to be in DSC, when using the criteria from Page-Dumroese, et al (2009). That impact was used to evaluate potential impacts in units. When mapped trails in Thomas Creek were clipped to existing unit boundaries, 31% of clipped trails were calculated as DSC. Using this method it was determined that 3% DSC was the greatest DSC finding in a given unit.

Therefore within the harvest units there is a total of 9 miles (13acres) of trail for a total of DSC (including system roads). Since only 31% of the evaluated impacts were deemed to be DSC; like alternative A, we can assume 31% of the total DSC is a loss to the soil resource (3 miles or 4 acres).

Of the legacy trails mapped in the project area, some measure of the road obliterated. Actual mileage of obliteration is dependent upon the amount of temporary road and legacy DSC overlap.

Further modeling of the proposed activities added the potential of lost EGC from wildfire and DSC for alternative A. The same model inputs were used in WEPP the Wildfire Scenario used in Alternative C, with the assumption that the proposed action would reduce the fire risk, so a Low Severity Fire was modeled (85% cover). In the modeling we see sediment input to streams similar to those created by the proposed activities (Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the proposed alternative in the recent past, nor will it play a role in this alternative or the foreseeable future.

Table 4). This modeling indicates; after the project is implemented, the assumed effects of wildfire would not be as intense and thus produce unmeasurable effects from the proposal and its required mitigations.

Provided all mitigating factors are present when proposed activity occurs, the anticipated DSC for a given unit or the proposal (as a whole) does not exceed 20% DSC criteria (LRMP).

### Cumulative Effects

*Spatial and Temporal Context for Effects Analysis*

### Cumulative effects are not expected from Resource Indicator and Measure (RIM) 1 – Mass movement, (Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the proposed alternative in the recent past, nor will it play a role in this alternative or the foreseeable future.

Table 4).

Cumulative effects from RIM 2 – Erosion, are expected to be localized; unless influenced by a combination of wildfire and the erosion processes exposed to high winds. Winds can transport detached soil aloft and to a new location. This would prove to be a loss to soil productivity within a proposed unit, if this occurs it is unknown if some portion of this material would end up as sediment. The potential duration of expected erosion risk would be for at least 3 years immediately following wildfire (Elliott et al 2001 and Robichaud 2000). The volumes of erosion under this risk are also influenced by the intensity and duration of precipitation events that occur during elevated erosion risk.

Cumulative effects from RIM 3 – Sediment, are expected to be small with no elevation above assumed background levels (Helvey and Fowler 1995) with the described mitigations and BMPs; unless like above influenced by wildfire. If wildfire takes place elevated. The potential duration of expected sediment risk would be for at least 3 years immediately following wildfire (Elliott et al 2001 and Robichaud 2000), assuming for a low severity wildfire and the reduced fuel loads.

## Alternative D

### Project Design Features and Mitigation Measures

Per Multi-Use Sustainable Yield Act, FSM and LRMP the following design features and mitigations will be placed on Alternative D.

1. Use of harvest equipment will not be permitted when soils reach field capacity for moisture, to limit the potential of long-term detrimental soil disturbance (Amaranthus et al. 1996, Bulmer et al. 2010, Froehlich et al. 1983, Heninger et al, 2002, Miller et al. 2004 and Page-Dumroese et al 2009.)

2. Within commercial harvest units, no harvest or heavy equipment will leave designated roads or trails, to limit the potential of detrimental soil disturbance. In the non-commercial thinning units, mechanical thinning equipment may be used provided that equipment that exceeds 7 PSI is not allowed to travel over the same path more than once. Some noncommercial thinning will be by sawyers (hand only).

3. In areas of harvest within the RHCA, no equipment or scour from skyline corridors will be allowed within either 75 or 100 feet of the water; depending upon RHCA slopes. In the WEPP modeling it was determined that these no equipment buffers are needed to limit scour from the repeated activities of ground based or skyline activities. To implement this design feature see Table 11 for criteria and distances.

A full list of BMPs, some with criteria driven by soil resource concerns have been incorporated within the EIS.

## Direct and Indirect Effects

**Table 6 Resource Indicators and Measures (RIM) for Alternative D**

| Resource Element | Resource Indicator | Measure | Miles | Acres |
|---|---|---|---|---|
| 1. Soil Stability | Soil Mass Wasting | No active areas identified | 0.0 | 0.0 |
| 2. Soil Productivity | Erosion | Activity unit acres modeled >0.03t/ac | 0.0 | 0 |
| 3. Water quantity | Sediment | Activity units that may produce >0.03t/ac | 0.0 | 0 |
| 4. Detrimental Soil Conditions (DSC) | Change or absence in vegetation growth | Total Disturbance | 7 | 11 |
| | | Assumed DSC within planning area (31% of impacted area) | 2 | 3 |

### Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the alternative D in the recent past, nor will it play a role in this alternative or the foreseeable future.

### Resource Indicator and Measure 2

Similar to the previous alternative; this alternative D will have some effect on Soil Productivity (Erosion): harvest (Ground Based, Skyline, Helicopter and Prescribed Burning). Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence erosion. Additionally there will be some Non Commercial Thinning (NCT) proposed. I t is not expected that this activity will have a Detrimental effect to the soils.

As mentioned in the existing condition discussion, there are existing DSC within activity areas from past activity. Some of the proposed activity impacts (Alt 3) will overlap with proposed temporary roads. During the implementation of activates, there will be some elevation of risk to erosion. However BMPs (erosion control) will mitigate or diminish; if not all most of the short term effects from erosion. To estimate this risk the WEPP model was used.

While the WEPP modeling did not take on the ground slope profiles to input into the model, a range of slope characteristics were identified in GIS that cover the range of slope conditions found within the proposed units. WEPP uses two elements in the model. The upper element represents the disturbance activity (i.e. harvest), and a low element which represents the sediment buffer to a waterway. In the model the steepest slopes found in the units were used to represent the worst case scenario for erosion modeling (upper element 60%, lower element 40% to 60%). To display differences in effect to the RHCA treatments, a variety of buffer widths were used in the model (Table 12).

Results of the model runs for harvest and burning treatments showed that average annual erosion was the same as Alternative D. The harvest example was using no disturbance other than removal of EGC. This is not to say under the extreme conditions (high precipitation, poor EGC left in place, or unplanned equipment traffic), erosion could not occur above background levels.

Based on the model runs and assumed background levels, it was determined that the harvest and prescribed burning would produce less sediment delivery than a high severity wildfire of similar size, so the Thomas Creek harvest and burning in RHCA would be justified and no soils specific Design Criteria is recommended based on canopy removal.

When the WEPP model used the criteria to examine skid trails there was elevated erosion, so design criteria was developed. This information was used to limit the length of trails (225ft and 600ft); acceptable skidding lengths are based on slope breaks and are defined in the Design Criteria of this EIS (Table 12).

The previously mentioned trails that will be used in the proposed activity as temporary roads will be subject to restoration (obliteration) of the DSC. As long as the proposed activity is allowed to use legacy trails, they can be eliminated by contract provision of a timber sales.

## Resource Indicator and Measure 3

In Alternative D there will be some effect to the Resource element of Water Quality (Sediment). In unit 94 there is a presence of an aquic soil (Balloontree Series), poorly drained soil mapped in a TEUI complex. This instance of Balloontree series is mapped along the northern edge of the unit and is associated with FS road 3100-284. However with appropriate road BMPs in place this condition is not expected to limit activities within the unit. Mentioned in the existing condition discussion there is existing DSC from past activities. Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence sediment. Some of the proposed activity impacts will overlap with proposed temporary roads. During the implementation of activates, there will be some elevation of risk to erosion. However BMPs (sediment) will mitigate or diminish; most if not all, short term effects from erosion. To estimate this sediment risk the WEPP model was used the two soil textures of loam and silt loam are the only soil textures that were mapped within the proposed units.

Results of the model runs for harvest and burning treatments showed that average annual sediment was below background, <0.03t/ac (Helvey and Fowler 1995). This means that harvest of trees (in or out of the RHCA), to the prescribed canopy density (>40% cover); would not show a measureable effect from sediment. This is not to say all proposed activities (in or out of the RHCA) would not have an effect to sediment (Table 12). Since skid trails are often extremely deficient of EGC, additional modeling was done to examine skid trails. Skid trails (a yarding method) are the one example when sediment could rise above background levels. A cover of 10% (skid trails) was used in WEPP model runs (Table 12). When skidding of trees was examined in relationship to the RHCA thinning, unlike the felling of trees; it was determined that a buffer was indeed needed to minimize the risk of sediment to streams.

Using the WEPP model runs and assumed background levels, it was assumed that the harvest and prescribed burning would produce less sediment delivery than a high severity wildfire of similar size. The analysis thereby shows that the Thomas Creek harvest and burning in RHCA would be justified and no Design Criteria is recommended based on canopy removal. Skid trails however may not be allowed to get closer than 75ft from a stream in RHCA treatments; in cases of increased slopes that buffer can be 100ft (Table 11). With all other streams the normal buffer distances will still apply, for both harvest and equipment traffic.

Some benefits to the sediment are expected from this alternative. As previously mentioned there are existing legacy trails. Some of these trails will be used as temporary roads in the project and subject to removal per the forest plan. Additionally since the temporary roads are used in the timber sale itself, it is allowable that under contract provisions of the timber sale they can be obliterated. These obliterated roads are considered restoration of the soil resource; in the event of a wildfire or similar defoliating event, the obliterated road will not offer a means of sediment inputs.

### Resource Indicator and Measure 4

In Alternative D there will be some effect to Detrimental Soil Conditions (DSC). Mentioned in the existing condition discussion there is existing DSC from past activities. Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence sediment.

While Reeves offers a comprehensive list of expected detrimental effects, it appears these estimates may underestimate effects if certain conditions are present or absent. To offer an expected DSC that may be relevant to proposed activities and conditions present the following were used in DSC calculations; Ground Based 10% (Archuleta, 1997 & 1999), Skyline 5%, Helicopter (Siskiyou NF, 1997), Prescribed Burning (Bennett, 1982). Additionally, there may be some use of ground based equipment to pre-bunch helicopter loads to improve efficiency of helicopter logging. This activity will be done with a single pass to limit DSC described by Han (2006); the soil moisture for this activity will also be limited to dry conditions as a further mitigation.

In the same way Alternative B described mitigation of DSC with slash Alternative will also rely on slash to minimize DSC with some ground based methods. The comparison in Figure 2 is important for the Thomas Creek analysis; it is assumed that the opportunity to mitigate equipment disturbance with slash may not be an option in many Thomas Creek project units. Therefore if harvester logging is used during implementation; it must occur after the soil has transitioned from moist to dry soil conditions. If this design criterion is not followed, the resulting effect will likely be similar to the skidder disturbance seen in Figure 2.

After the issuance of draft documentation of this project it was recognized that retention of unit 34 (ground based harvest) in Alternative D will require additional access given its spatial distance to an FS road location. Direction to the ID team (Hutchinson, 2016), was to retain this unit within the analysis. Per this direction, the unit access will be considered as longer skidding for this analysis. When considering the effects of longer skidding as access to a unit, it is assumed equipment traffic will need to make repeated passes. The effect of additional passes will increase the organic displacement and compaction of soil within the travel path (Froehlich 1983), and reduce the productivity of the soil (Amaranthus 1996, and Arocena 1999). Because of this additional impact, it will be very likely the effects to the soil will mimic that of a temporary road. However without the designation of temporary road in Alternative D, this impact may not require temporary road obliteration (Umatilla LRMP).

The comparison in Figure 3 is important for the Thomas Creek analysis; it is assumed that the opportunity to mitigate equipment disturbance with slash may not be an option in many Thomas Creek project units. Therefore if harvester logging is used during implementation; it must occur after the soil has transitioned from moist to dry soil conditions. If this design criterion is not followed, the resulting effect will likely be similar to the skidder disturbance seen in Figure 3.

The elements of DSC are currently present in proposed units and will change in some areas by proposed activities. This change will take place mostly in association with the overlap of legacy trails and new temporary roads. Where this overlap occurs it is expected that there will an overall decrease in DSC for that segment of legacy trail. Within the proposed planning area there are human created trails that measure approximately 23 miles of assumed trail.

The inhibition on plant growth seems to be related to trees and brush; grasses, herbs and forbs in general may also have been influenced, but no measureable change was identified in the soils report. Estimates of DSC (Table 4) are based on field observations (Table 14); the effects appear to be similar to those made in the Kahler project. Within Kahler 31% of the observed impacts was considered to be in DSC, when using the criteria from Page-Dumroese, et al (2009). That impact was used to evaluate potential impacts in units. When mapped trails in Thomas Creek were clipped to existing unit boundaries, 31% of clipped trails were calculated as DSC. Using this method it was determined that 3% DSC was the greatest DSC finding in a given unit.

Therefore within the harvest units there is a total of 7 miles (11acres) of trail for a total of DSC (including system roads). Since only 31% of the evaluated impacts were deemed to be DSC; like alternative A, we can assume 31% of the total DSC is a loss to the soil resource (2 miles or 3 acres).

Of the legacy trails mapped in the project area, some measure of the road obliterated. Actual mileage of obliteration is dependent upon the amount of temporary road and legacy DSC overlap.

Further modeling of the proposed activities added the potential of lost EGC from wildfire and DSC for alternative A. The same model inputs were used in WEPP the Wildfire Scenario used in Alternative D, with the assumption that the proposed action would reduce the fire risk, so a Low Severity Fire was modeled (85% cover). In the modeling we see sediment input to streams similar to those created by the proposed activities (Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the proposed alternative in the recent past, nor will it play a role in this alternative or the foreseeable future.

Table 4). This modeling indicates; after the project is implemented, the assumed effects of wildfire would not be as intense and thus produce unmeasurable effects from the proposal and its required mitigations.

Provided all mitigating factors are present when proposed activity occurs, the anticipated DSC for a given unit or the proposal (as a whole) does not exceed 20% DSC criteria (LRMP).

## Cumulative Effects

### *Spatial and Temporal Context for Effects Analysis*

### Cumulative effects are not expected from Resource Indicator and Measure (RIM) 1 – Mass movement, (Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the proposed alternative in the recent past, nor will it play a role in this alternative or the foreseeable future.

Table 4).

Cumulative effects from RIM 2 – Erosion, are expected to be localized; unless influenced by a combination of wildfire and the erosion processes exposed to high winds. Winds can transport detached soil aloft and to a new location. This would prove to be a loss to soil productivity within a proposed unit, if this occurs it is unknown if some portion of this material would end up as sediment. The potential duration of expected erosion risk would be for at least 3 years immediately following wildfire (Elliott et al 2001 and Robichaud 2000). The volumes of erosion under this risk are also influenced by the intensity and duration of precipitation events that occur during elevated erosion risk.

Cumulative effects from RIM 3 – Sediment, are expected to be small with no elevation above assumed background levels (Helvey and Fowler 1995) with the described mitigations and BMPs; unless like above influenced by wildfire. If wildfire takes place elevated. The potential duration of expected sediment risk would be for at least 3 years immediately following wildfire (Elliott et al 2001 and Robichaud 2000), assuming for a low severity wildfire and the reduced fuel loads.

Cumulative effects from RIM 4 – With regard to potential to change in vegetation growth, dropping temporary roads will play a role. While there would be no DSC increase to current conditions by dropping temporary roads in the project. The benefit of temporary road obliteration (LRMP) would also not take place. Additionally, since the designation of temporary roads is not used. The access activities called long skidding (mentioned page 23 of this document), would not be obliterated and on a very small scale (<1ac) this impact could diminish future vegetation growth (Amaranthus et al. 1996, Bulmer et al. 2010, Froehlich et al. 1983, Heninger et al, 2002, Miller et al. 2004 and Page-Dumroese et al 2009.), within the equipment traffic footprint. This would not change the overall totals to DSC for this project.

## Alternative E

### Project Design Features and Mitigation Measures

Per Multi-Use Sustainable Yield Act, FSM and LRMP the following design features and mitigations will be placed on Alternative 4.

1. Use of harvest equipment will not be permitted when soils reach field capacity for moisture, to limit the potential of long-term detrimental soil disturbance (Amaranthus et al. 1996, Bulmer et al. 2010, Froehlich et al. 1983, Heninger et al, 2002, Miller et al. 2004 and Page-Dumroese et al 2009.)

2. Placement of new temporary roads will be on deep soils, if it is operationally feasible. This will allow for adequate restoration of temporary roads and over time will leave less measurable detrimental soil condition across the proposed activity units (Archuleta, 2006, 2007, 2008). Lithosol (scab flats) and meadows will not be used for landings and skid trails; unless no other location is practical. If use is necessary disturbance will be kept to a minimum amount of the area, preferably at the edges of these features.

3. Within commercial harvest units, no harvest or heavy equipment will leave designated roads or trails, to limit the potential of detrimental soil disturbance. In the non-commercial thinning units, mechanical thinning equipment may be used provided that equipment that exceeds 7 PSI is not allowed to travel over the same path more than once. Some noncommercial thinning will be by sawyers (hand only).

4. In areas of harvest within the RHCA, no equipment or scour from skyline corridors will be allowed within either 75 or 100 feet of the water; depending upon RHCA slopes. In the WEPP modeling it was determined that these no equipment buffers are needed to limit scour from the repeated activities of ground based or skyline activities. To implement this design feature see Table 11 for criteria and distances.

A full list of BMPs, some with criteria driven by soil resource concerns have been incorporated within the EIS.

## Direct and Indirect Effects

### Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the alternative 4 in the recent past, nor will it play a role in this alternative or the foreseeable future.

**Table 7 Resource Indicators and Measures (RIM) for Alternative E**

| Resource Element | Resource Indicator | Measure | Miles | Acres |
|---|---|---|---|---|
| 1. Soil Stability | Soil Mass Wasting | No active areas identified | 0.0 | 0.0 |
| 2. Soil Productivity | Erosion | Activity unit acres modeled >0.03t/ac | 0.0 | 0 |
| 3. Water quantity | Sediment | Activity units that may produce >0.03t/ac | 0.0 | 0 |
| 4. Detrimental Soil Conditions (DSC) | Change or absence in vegetation growth | Total Disturbance | 8 | 12 |
| | | Assumed DSC within planning area (31% of impacted area) | 3 | 4 |

### Resource Indicator and Measure 2

Similar to the previous alternatives the proposed activities of this alternative will have some effect on Soil Productivity (Erosion): harvest (Ground Based, Skyline, Helicopter and Prescribed Burning). Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence erosion. Additionally there will be some Non Commercial Thinning (NCT) proposed. I t is not expected that this activity will have a Detrimental effect to the soils.

As mentioned in the existing condition discussion, there are existing DSC within activity areas from past activity. Some of the proposed activity impacts (Alternative E) will overlap with proposed temporary roads. During the implementation of activates, there will be some elevation of risk to erosion. However BMPs (erosion control) will mitigate or diminish in most cases.

When the WEPP model used the criteria to examine skid trails there was elevated erosion, so design criteria was developed. This information was used to limit the length of trails (225ft and 600ft); acceptable skidding lengths are based on slope breaks and are defined in the Design Criteria of this EIS (Table 12).

The previously mentioned trails that will be used in the proposed activity as temporary roads some will be subject to restoration (obliteration) of the DSC. As long as the proposed activity is allowed to use legacy trails, they can be eliminated by contract provision of a timber sales. Obliteration of long skid trails will not be proposed in this alternative. However it is recommended that the locations of these trails be recorded and monitored to effects overtime.

### Resource Indicator and Measure 3

In Alternative 4 there will be some effect to the Resource element of Water Quality (Sediment). In unit 94 there is a presence of an aquic soil (Balloontree Series), poorly drained soil mapped in a TEUI complex. This instance of Balloontree series is mapped along the northern edge of the unit and is associated with FS road 3100-284. However with appropriate road BMPs in place this condition is not expected to limit activities within the unit. Mentioned in the existing condition discussion there is existing DSC from past activities. Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence sediment. Some of the proposed activity impacts will overlap with proposed temporary roads. During the implementation of activates, there will be some elevation of risk to erosion. However BMPs (sediment) will mitigate or diminish; most if not all, short term effects from erosion. To estimate this sediment risk the WEPP model was used the two soil textures of loam and silt loam are the only soil textures that were mapped within the proposed units.

Results of the model runs for harvest and burning treatments showed that average annual sediment was below background, <0.03t/ac (Helvey and Fowler 1995). This means that harvest of trees (in or out of the RHCA), to the prescribed canopy density (>40% cover); would not show a measureable effect from sediment. This is not to say all proposed activities (in or out of the RHCA) would not have an effect to sediment (Table 12). Since skid trails are often extremely deficient of EGC, additional modeling was done to examine skid trails. Skid trails (a yarding method) are the one example when sediment could rise above background levels. A cover of 10% (skid trails) was used in WEPP model runs (Table 12). When skidding of trees was examined in relationship to the RHCA buffers, unlike the felling of trees; it was determined that a no equipment buffer was indeed needed to minimize the risk of sediment to streams.

Based on the model runs and assumed background levels, it was assumed that the harvest and prescribed burning would produce less sediment delivery than a high severity wildfire of similar size. The analysis thereby shows that the Thomas Creek harvest and burning in RHCA would be justified and no Design Criteria is recommended based on canopy removal. Skid trails however may not be allowed to get closer than 75ft from a stream in RHCA treatments; in cases of increased slopes that buffer can be 100ft (Table 11). With all other streams the normal buffer distances will still apply, for both harvest and equipment traffic.

Some benefits to the sediment are expected from this alternative. As previously mentioned there are existing legacy trails. Some of these trails will be used as temporary roads in the project and subject to removal per the forest plan, though to a lesser extent than alternatives 2 and 3. Additionally since the temporary roads are used in the timber sale itself, it is allowable that under contract provisions of the timber sale they can be obliterated. These obliterated roads are considered restoration of the soil resource; in the event of a wildfire or similar defoliating event, the obliterated road will not offer a means of sediment inputs.

Despite the elimination of RHCA activity within this alternative; conditions and activities that can promote erosion occur in this alternative; long skid trails. However the WEPP analysis predicts that effective mitigation for that erosion can be achieved through the use of EGC (Effective Ground Cover). Provided that trails left in a compacted state retain ≥30% EGC or do not have greater than ft without a water bar; they should not produce erosion above background levels.

### Resource Indicator and Measure 4

In Alternative 4 there will be some effect to Detrimental Soil Conditions (DSC). Mentioned in the existing condition discussion there is existing DSC from past activities. Each of these methods has an expected impact to the DSC (Reeves, 2011, Archuleta, 1997 & 1999, Siskiyou NF, 1997 and Bennett, 1982), which can influence sediment.

While Reeves offers a comprehensive list of expected detrimental effects, it appears these estimates may underestimate effects if certain conditions are present or absent. To offer an expected DSC that may be relevant to proposed activities and conditions present the following were used in DSC calculations;

Ground Based 10% (Archuleta, 1997 & 1999), Skyline 5%, Helicopter (Siskiyou NF, 1997), Prescribed Burning (Bennett, 1982). Additionally, there may be some use of ground based equipment to pre-bunch helicopter loads to improve efficiency of helicopter logging. This activity will be done with a single pass to limit DSC described by Han (2006); the soil moisture for this activity will also be limited to dry conditions as a further mitigation.

In the same way Alternative B described mitigation of DSC with slash Alternative will also rely on slash to minimize DSC with some ground based methods. The comparison in Figure 2 is important for the Thomas Creek analysis; it is assumed that the opportunity to mitigate equipment disturbance with slash may not be an option in many Thomas Creek project units. Therefore if harvester logging is used during implementation; it must occur after the soil has transitioned from moist to dry soil conditions. If this design criterion is not followed, the resulting effect will likely be similar to the skidder disturbance seen in Figure 2.

The elements of DSC are currently present in proposed units and will change in some areas by proposed activities. This change will take place mostly in association with the overlap of legacy trails and new temporary roads. Where this overlap occurs it is expected that there will an overall decrease in DSC for that segment of legacy trail. Within the proposed planning area there are human created trails that measure approximately 23 miles of assumed trail.

The inhibition on plant growth seems to be related to trees and brush; grasses, herbs and forbs in general may also have been influenced, but no measureable change was identified in the soils report. Estimates of DSC (Table 4) are based on field observations (Table 14); the effects appear to be similar to those made in the Kahler project. Within Kahler 31% of the observed impacts was considered to be in DSC, when using the criteria from Page-Dumroese, et al (2009). That impact was used to evaluate potential impacts in units. When mapped trails in Thomas Creek were clipped to existing unit boundaries, 31% of clipped trails were calculated as DSC. Using this method it was determined that 3% DSC was the greatest DSC finding in a given unit.

Therefore within the harvest units there is a total of 8 miles (12 acres) of trail for a total of DSC (including system roads). Since only 31% of the evaluated impacts were deemed to be DSC; like alternative A, we can assume 31% of the total DSC is a loss to the soil resource (3 miles or 4 acres).

Of the legacy trails mapped in the project area, some measure of the road obliterated. Actual mileage of obliteration is dependent upon the amount of temporary road and legacy DSC overlap.

Further modeling of the proposed activities added the potential of lost EGC from wildfire and DSC for alternative A. The same model inputs were used in WEPP the Wildfire Scenario used in Alternative E, with the assumption that the proposed action would reduce the fire risk, so a Low Severity Fire was modeled (85% cover). In the modeling we see sediment input to streams similar to those created by the proposed activities (Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the proposed alternative in the recent past, nor will it play a role in this alternative or the foreseeable future.

Table 4). This modeling indicates; after the project is implemented, the assumed effects of wildfire would not be as intense and thus produce unmeasurable effects from the proposal and its required mitigations.

Even with the additional acres of DSC from the effects of long skidding, with current and expected levels of DSC, this alternative does not exceed 20% DSC criteria (LRMP).

### Cumulative Effects

#### *Spatial and Temporal Context for Effects Analysis*

Cumulative effects are not expected from Resource Indicator and Measure (RIM) 1 – Mass movement, (Resource Indicator and Measure 1

Soil mass movement was not identified in the area or as a risk that should play a role in any of the proposed activity units, therefore, it is assumed that mass movement will not influence the proposed alternative in the recent past, nor will it play a role in this alternative or the foreseeable future.

Table 4).

Cumulative effects from RIM 2 – Erosion, are expected to be localized; unless influenced by a combination of wildfire and the erosion processes exposed to high winds. Winds can transport detached soil aloft and to a new location. This would prove to be a loss to soil productivity within a proposed unit, if this occurs it is unknown if some portion of this material would end up as sediment. The potential duration of expected erosion risk would be for at least 3 years immediately following wildfire (Elliott et al 2001 and Robichaud 2000). The volumes of erosion under this risk are also influenced by the intensity and duration of precipitation events that occur during elevated erosion risk.

Cumulative effects from RIM 3 – Sediment, are expected to be small with no elevation above assumed background levels (Helvey and Fowler 1995) with the described mitigations and BMPs; unless like above influenced by wildfire. If wildfire takes place elevated. The potential duration of expected sediment risk would be for at least 3 years immediately following wildfire (Elliott et al 2001 and Robichaud 2000), assuming for a low severity wildfire and the reduced fuel loads.

#### *Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis*

All ground disturbing activities included in the list of past, present and reasonably foreseeable activities for the Thomas Creek project in the EA (Chapter 3) are relevant to cumulative effects analysis for DSC

#### *Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis*

All ground disturbing activities included in the list of past, present and reasonably foreseeable activities for the Thomas Creek project in the EA (Chapter 3) are relevant to cumulative effects analysis for DSC.

# Regulatory Framework

## Land and Resource Management Plan

The Umatilla National Forest Land and Resource Management Plan (LRMP) provides standards and guidelines for all activities.

The Desired Future Condition in the 1990 Forest Plan (LRMP) for water/soil is to maintain soil productivity (Forest Plan p. 4-9). The plan further states that Standards and Guidelines are to maintain a minimum of 80 percent of an activity area in a condition of acceptable productivity potential. Acceptable productivity is defined as:

- Less than 20% increase in bulk density of volcanic soil or a less than 15 percent increase in soil bulk density for other forest soils.
- Soil disturbance of less than 50 percent of the topsoil humus enriched A1 and or AC horizons from an area 100 sq. ft. (i.e. 5ft by 20ft)

  - Molding of the soil in vehicle tracks that area rutted to a depth less than 6 inches.

- Severely burned soil with the top layer of mineral soil altered in color (usually to red) and the next ½ inch blackened from organic matter charring.
- Plan and conduct land management activities so that soil loss from surface erosion and mass wasting, caused by activities will not result in an unacceptable reduction in soil productivity or water quality.
- Management activities shall be designed and implemented to retain sufficient ground vegetation and organic matter to maintain long-term soil and site productivity.
- Active slump and landslide area are considered unavailable for road construction. Areas with known landslide potential and lake sediments require special transportation planning and design, layout preconstruction, construction and maintenance techniques.

## Federal Law

### Multi-Use Sustainable Yield Act (1960)

The project with described mitigation and BMPs in place should be able to meet the intent and direction of the Sustained Yield Act. Sustained yield means achieving and maintaining into perpetuity a high-level annual or regular periodic output of renewable resources without impairment of the productivity of the land.

### Clean Water Act

Minimizing the risk of sediment within the project and its design criteria was considered to help the Thomas Creek Project meet the Clean Water Act.

## Compliance with LRMP and Other Relevant Laws, Regulations, Policies and Plans

For the proposed actions within this proposed project there are no activities expected to exceed DSC defined by the forest plan. The highest expected DSC will be in unit the ground based unit 21 (17% or 8.7 acres DSC). The lowest DSC will be 11% in a variety of units.

The project with described mitigation and BMPs in place should be able to meet the intent and direction of the LRMP as it pertains to the soil resource.

It is assumed that the project being able to meet LRMP and FSM will lead to a project that will be considered sustainable in the terms of the Sustained Yield Act.

### Short-term Uses and Long-term Productivity

Related to temporary roads in general, provided they are placed on a soil depth were restoration is possible, temporary roads can truly be temporary on the landscape. Often it is assumed that these activities will never return to a previous impact condition. When the literature is examined in this respect we see that numerous authors find this not to be the case (Archuleta, 2007 and 2008, Heninger et al 2002, Luce 1997). Taking this information into account we can assume that the installation (or reconstruction), use then obliteration of temporary roads will be short lived and that the effects will not harm the long-term productivity of the soil resource.

## Unavoidable Adverse Effects

## Irreversible and Irretrievable Commitments of Resources

As it may apply to temporary roads placed on shallow soils, these effects may be irreversible depending upon the depth of impact, organic matter present in the soil and the depth of the soil itself. While these areas are of minimal importance to timber production, but have a multitude of other resource values. These impacts over time may be colonized by noxious weeds and other pioneer species suited to such undeveloped conditions; which may lead to other resource damage. Therefore these types of impacts are expected to minimize to reduce the occurrence of irreversible damage to the soil resource.

# Summary of Environmental Effects

**Table 8 Summary of Environmental Effects for the Thomas Creek Project**

| Resource Element | Indicator/Measure | Alt A | Alt B | Alt C | Alt D | Alt E |
|---|---|---|---|---|---|---|
| Soil Stability | Soil Mass Wasting | No effect. | No effect | No Effect | No effect | No effect |
| Soil Productivity | Erosion | Given the current EGC the expectation of erosion elevated above background. However if the loss of EGC were to occur existing DSC 400ft from streams may produce some erosion. It is conceivable that these DSC features could route erosion to streams. | Given the proposed EGC in this alternative there is no expectation of erosion elevated above background. This is also true with the occurrence of a wildfire after treatment | Given the proposed EGC in this alternative there is no expectation of erosion elevated above background. This is also true with the occurrence of a wildfire after treatment | Given the proposed EGC in this alternative there is no expectation of erosion elevated above background. This is also true with the occurrence of a wildfire after treatment | Given the proposed EGC in this alternative there is no expectation of erosion elevated above background. However there will be acres where DSC will limit the soils ability to produce EGC. This is also true with the occurrence of a wildfire after treatment |
| Water Quality | Sediment | Given the current EGC there is no expectation of sediment above background. However if the loss of EGC were to occur; existing DSC within 400ft of streams could offer a conduit sediment to streams above background levels | Given the proposed EGC in this alternative there is no expectation of sediment above background. This will be true provided the buffer distances within RHCA are followed. | Even with the addition of acres in the experimental design, the proposed EGC in this alternative there is no expectation of sediment above background. This will be true provided the buffer distances within RHCA are followed. | Given the proposed EGC in this alternative there is no expectation of sediment above background. This will be true provided the buffer distances within RHCA are followed. | Given the proposed EGC in this alternative there is no expectation of sediment above background. This will be true provided the buffer distances within RHCA are followed. |
| Existing DSC | Change in vegetation growth | With this alternative there is no opportunity to obliterate existing DSC. These areas | With this alternative there is opportunity to obliterate existing DSC. This alternative | With this alternative there is opportunity to obliterate existing DSC. This alternative | With this alternative there is a reduced opportunity to obliterate existing DSC (Temporary | With this alternative there is opportunity to obliterate existing DSC These areas |

| Resource Element | Indicator/Measure | Alt A | Alt B | Alt C | Alt D | Alt E |
|---|---|---|---|---|---|---|
| | | will continue to have diminished soil both in and out RHCA. | will increase soil productivity both in and out RHCA. | will increase soil productivity both in and out RHCA | Roads).. These areas will continue to be diminished both in and out RHCA. | will continue to be diminished both in and out RHCA. |

When we consider the presence of Mollisols (grass developed soils) within the proposed units, this suggests that the development of these stands has a wide range of variability in vegetative cover. This information should be important to all alternatives when considering the past conditions and the potentially changing climate in the area. Taking these factors into account it is not expected that the proposed activities will harm or alter the further development of these soils.

Soil stability will not be changed by this project in any alternative. The no action alternative will leave more DSC on the landscape that any of the action alternatives. This assumption is based on the observation of DSC within units from previous activities and no mitigating effects in the no action alternative to temporary roads and landings. These impacts if uncovered by a wildfire, this disturbance may serve as a conduit for erosion and sediment over a short period ($\leq$3years) to longer durations (14 years), depending upon the intensity of the wildfire (Robichaud, 2000).

# Appendix

## Acronyms

WEPP – Water Erosion Prediction Program, Forest Service model. Developed and tested by the Rocky Mountain Research Stations (RMRS).

TEUI – Terrestrial Ecosystem Unit Inventory, 3rd order soil survey with outputs compatible with NRCS county soil surveys.

## Glossary

Pedoturbation – Mixing within a soil or sediment profile by various processes, such as animal burrowing, tree throw, freeze-thaw cycles, etc. It usually involves disturbance of the skeletal fabric as opposed to redistribution of only fine particles.

Chroma (Soil Color)

The relative purity, strength, or saturation of a color; directly related to the dominance of the determining wavelength of the light and inversely related to grayness; one of the three variables of color. See also Munsell color system, hue, and value.

Soil Orders

Andisol – development influenced by volcanic ejecta

Mollisol – Soft and dark from organic materials, typically formed under grasslands

Mixed – Various combinations of Inseptisol-Andisol-Mollisol, Mollisol-Andisol-Mollisol, Andisol-Mollisol-Mollisol, & Andisol-Andisol-Mollisol

Soil-disturbance Classes

Soil Disturbance Class 0 – Undisturbed

No evidence of past equipment. No depressions or wheel tracks. Forest-floor layers are present and intact. No soil displacement evident. No management-generated soil erosion. No management-created soil compaction. No management-created platy soils.

Soil-Disturbance Class 1

Wheel tracks or depressions are evident, but faint and shallow. Forest-floor layers are present and intact. Surface soil has not been displaced. Soil burn severity from prescribed fires is low (slight charring of vegetation, discontinuous). Soil compaction is shallow (0 to 4 inches). Soil structure is changed from undisturbed conditions to platy or massive albeit discontinuous.

Soil Disturbance Class 2

Wheel tracks or depressions are evident and moderately deep. Forest-floor layers are partially missing. Surface soil partially intact and maybe mixed with subsoil. Soil burn severity from prescribed fires is moderate (black ash evident and water repellency may be increased compared to pre-burn condition). Soil compaction is moderately deep (up to 12 inches). Soil structure is changed from undisturbed conditions and may be platy or massive.

Soil Disturbance Class 3

Wheel tracks or depressions are evident and deep. Forest-floor layers are missing. Surface soil is removed through gouging or piling. Surface soil is displaced. Soil burn severity from prescribed fires is high (white or reddish ash, all litter completely consumed, and soil structureless). Soil compaction is persistent and deep (greater than 12 inches). Soil structure is changed from undisturbed and is platy or massive throughout.

Soil Resource Inventories (SRIs)

Soil Survey Geographic Database (SSURGO)

Temporary Road

(FSM 7700) - A road necessary for emergency operations or authorized by contract, permit, lease, or other written authorization that is not a forest road and that is not included in a forest transportation atlas.

(LRMP) – Short term (temporary) roads will be obliterated.

Comment: For timber sale purposes, a temporary road is any haul route between a loading site and a forest road. An existing unauthorized road (see below) may only be used as a haul route once it has been authorized (new specified road construction or temporary road construction).

WEPP Inputs

Soil Texture, generated from TEUI

Cover (Treatment/Vegetation Buffer) for both Upper and Lower

Mature Forest = 100% (used for undisturbed forest)

Poor Grass = 40% (used for harvest removal)

Skid Trail = 10% *(used for equipment effects0

High Severity Wildfire = 45% (used for fire consumption in Alt 1)

Low Severity Wildfire = 85% (used for fire consumption in Alts 2 & 3

Gradient % (slopes) Range based on unit information

Horizontal Length (ft.) 700ft used to mimic; 6ooft skid trails and 100ft Class 4 RHCA buffer, 300ft used to mimic 200ft skid trails and 100ft class 4 RHCA buffer.

Rock (%)

## Soil Descriptions Mapped within Project Area

Within the project area there are 38 individual soil series identified. Each is series is then mapped with a soil consociations, associations or a complex. The consociation is a single series, while the complex is composed of two or more soils series, or soils and a miscellaneous area (Rock Outcrop), plus allowable inclusions in either case. In the case of the complexes, each has a dominant soil; which is the first series used within the complex name. Within the project area there is one consociation (Bocker Series), the remaining 68 complex map units within the area are comprised of various series (listed below) or soil series complexes include rock outcrops.

ANATONE SERIES

The Anatone series consists of shallow, well drained soils formed in loess and ash mixed with residuum and colluvium from basalt, andesite or welded tuff. Anatone soils are on mountain side slopes, plateaus and ridgetops. Slopes are 0 to 90 percent. The mean annual precipitation is about 23 inches and the mean annual temperature is about 43 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive, frigid Lithic Haploxerolls

TYPICAL PEDON: Anatone very cobbly silt loam, pasture.

BALLOONTREE SERIES

The Balloontree series consists of very deep, somewhat poorly drained soils on gentle mountain backslopes and plateaus. Balloontree soils formed in volcanic ash over loess and colluvium from basalt. Slopes are 0 to 15 percent. Mean annual precipitation is about 53 inches and mean annual air temperature about 38 degrees F.

TAXONOMIC CLASS: Ashy over loamy, amorphic over isotic Aquic Vitricryands

TYPICAL PEDON: Balloontree ashy silt loam forested, on a 5 percent linear north facing slope at 5,100 feet elevation. (Colors are for moist soil unless otherwise noted.)

BOCKER SERIES

The Bocker series consists of very shallow, well drained soils formed in colluvium and residuum derived from basalt mixed with loess and a small amount of volcanic ash in the surface. Bocker soils are on plateaus, hills and mountains. Slopes are 0 to 90 percent. The mean annual precipitation is about 25 inches and means annual temperature is about 42 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive, frigid Lithic Haploxerolls

TYPICAL PEDON: Bocker very cobbly silt loam - rangeland

DARDRY SERIES

The Dardry series consists of very deep, well drained soils on high terraces of mountain valley floors and mountain toeslopes. Dardry soils formed in stream alluvium from mixed rocks. Slopes are 0 to 10 percent. Mean annual precipitation is about 26 inches and mean annual temperature about 45 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive, frigid Cumulic Ultic Haploxerolls

TYPICAL PEDON: Dardry loam - woodland, on a 0 percent slope at an elevation of 3,760 feet. (Colors are for moist soil unless otherwise noted. Soil textures are apparent field textures.).

FIVEBEAVER SERIES

The Fivebeaver series consists of shallow, well-drained soils on plateaus and backslopes of mountains. Fivebeaver soils formed in colluvium from basalt or andesite mixed with a small amount of volcanic ash. Slopes are 0 to 90 percent. Mean annual precipitation is about 30 inches and mean annual temperature about 42 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, isotic, frigid Lithic Ultic Haploxerolls

TYPICAL PEDON: Fivebeaver gravelly ashy silt loam, forested, on an 8 percent northeast slope at 4,940 feet elevation.

GETAWAY SERIES

The Getaway series consists of deep, well drained soils formed in loess and colluvium from basalt, andesite, or andesitic basalt with an influence of volcanic ash mixed in the surface. Getaway soils are on mountain side slopes and canyon walls. Slopes are 15 to 90 percent. The mean annual precipitation is about 27 inches and the mean annual temperature is about 43 degrees F.
TAXONOMIC CLASS: Loamy-skeletal, isotic, frigid Vitrandic Argixerolls
TYPICAL PEDON: Getaway stony ashy silt loam- forested, on a 76 percent northwest-facing slope at an elevation of 3,360 feet. (Colors are for dry soils unless otherwise noted)

HARL SERIES

The Harl series consists of very deep, well drained soils on side slopes of plateaus, canyons and mountains. Harl soils formed in volcanic ash over colluvium derived from basalt. Slopes are 30 to 90 percent. The mean annual precipitation is about 30 inches and the mean annual temperature is about 43 degrees F.
TAXONOMIC CLASS: Ashy-skeletal over loamy-skeletal, amorphic over isotic, frigid Typic Udivitrands
TYPICAL PEDON: Harl very gravelly ashy silt loam - Woodland, on a 65 percent planar northwest-facing slope at an elevation of 4,600 feet. (Colors are for moist soil unless otherwise noted.)

KAMELA SERIES

The Kamela series consists of moderately deep, well drained soils that formed in residuum and colluvium weathered from basalt, with an influence of loess and volcanic ash in the surface. Kamela soils are on mountains and have slopes of 0 to 90 percent. The mean annual precipitation is about 30 inches and the mean annual temperature is about 43 degrees F.
TAXONOMIC CLASS: Loamy-skeletal, isotic, frigid Vitrandic Haploxerepts
TYPICAL PEDON: Kamela stony ashy silt loam, timbered.

KLICKER SERIES

The Klicker series consists of moderately deep well drained soils formed in loess mixed with volcanic ash, and slope alluvium and colluvium from basalt. Klicker soils are on mountains, plateaus, and benches. Slopes are 0 to 90 percent. The average annual precipitation is about 30 inches and average annual temperature is about 42 degrees F.
TAXONOMIC CLASS: Loamy-skeletal, isotic, frigid Vitrandic Argixerolls
TYPICAL PEDON: Klicker stony ashy silt loam- forested

LARABEE SERIES

The Larabee series consists of well drained, moderately deep soils on hills and canyons. They formed in colluvium weathered from basalt or welded tuff with an influence of loess and volcanic ash. Permeability is moderately slow. Slope ranges from 0 to 90 percent. The average annual temperature is about 43 degrees F and the average annual precipitation is about 27 inches.
TAXONOMIC CLASS: Loamy-skeletal, isotic, frigid Vitrandic Argixerolls
TYPICAL PEDON: Larabee ashy loam -- on a 22 percent south-facing slope at 4,690 feet elevation in forest.

LIMBERJIM SERIES

The Limberjim series consists of deep, well drained soils on stable slopes of mountains, plateaus, canyons, and structural benches. Limberjim soils formed in ash over colluvium and residuum derived from basalt and andesitic breccias. Slopes are 0 to 90 percent. The mean annual precipitation is about 30 inches and the mean annual temperature is about 43 degrees F.
TAXONOMIC CLASS: Ashy over loamy-skeletal, amorphic over isotic, frigid Alfic Udivitrands
TYPICAL PEDON: Limberjim ashy silt loam - Woodland, on a 5 percent planar southeast-facing slope at an elevation of 4,490 feet.

MOUNTEMILY SERIES

The Mountemily series consists of very deep, well drained soils on ridgetops, side slopes and shoulders of mountains. Mountemily soils are formed in volcanic ash overlying colluvium derived from basalt and andesitic basalt. Slopes are 0 to 90 percent. The mean annual precipitation is about 38 inches and the mean annual temperature is about 37 degrees F.

TAXONOMIC CLASS: Ashy over loamy-skeletal, amorphic over isotic Typic Vitricryands

TYPICAL PEDON: Mountemily ashy silt loam - woodland, on a 43 percent convex north-facing slope at an elevation of 5,740 feet. (Colors are for moist soil unless otherwise noted. All textures are apparent field textures.)

MOUNTIRELAND SERIES

The MountIreland series consists of deep and very deep, moderately well drained soils on lower backslopes, footslopes and toeslopes of mountains. MountIreland soils are formed in volcanic ash overlying colluvium and residuum from andesites, or basalts. Slopes are 0 to 60 percent. The mean annual precipitation is about 48 inches and the mean annual temperature is about 37 degrees F.

TAXONOMIC CLASS: Ashy over loamy, amorphic over isotic Alfic Vitricryands

TYPICAL PEDON: MountIreland ashy silt loam, woodland, on a 5 percent south-facing slope at an elevation of 5,870 feet. (Colors are for moist soil unless otherwise noted.)

MUGWUMP SERIES

The Mugwump series consists of very deep, well or moderately well drained soils on planar and complex terraces of mountain valley floors. Mugwump soils formed in mixed alluvium. Slopes are 0 to 25 percent. Mean annual precipitation is about 30 inches and mean annual temperature about 42 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive, frigid Cumulic Hapludolls

TYPICAL PEDON: Mugwump sandy loam - woodland, on a 3 percent slope at elevation of 4,380 feet. (Colors are for moist soil unless otherwise noted. Soil textures are apparent field textures.)

OLOT SERIES

The Olot series consists of moderately deep, well drained soils that formed in volcanic ash and colluvium and residuum weathered from basalt. Olot soils are on plateaus and mountains and have slopes of 2 to 90 percent. The mean annual precipitation is about 27 inches and the mean annual temperature is about 44 degrees F.

TAXONOMIC CLASS: Ashy over loamy-skeletal, glassy over isotic, frigid Typic Vitrixerands

TYPICAL PEDON: Olot stony ashy silt loam, wooded.

SYRUPCREEK SERIES

The Syrupcreek series consists of moderately deep, well drained soils on ridgetops and side slopes of mountains and plateaus. Syrupcreek soils formed in ash and loess over colluvium and residuum derived from basalt and andesitic brecias. Slopes are 0 to 60 percent. The mean annual precipitation is about 35 inches and the mean annual temperature is about 43 degrees F.

TAXONOMIC CLASS: Ashy over loamy-skeletal, amorphic over isotic, frigid Alfic Udivitrands

TYPICAL PEDON: Syrupcreek ashy silt loam - Woodland, on a 3 percent planar northeast-facing slope at an elevation of 4385 feet.

TAMARA SERIES

The Tamara series consists of very deep, well drained soils on dissected basalt plateaus, canyons and mountains. Tamara soils are formed in a mantle of volcanic ash overlying material derived from a mixture of loess and colluvium and residuum from basalt. Slopes are 0 to 60 percent. The mean annual precipitation is about 30 inches and the mean annual temperature is about 38 degrees F.

TAXONOMIC CLASS: Ashy over loamy, amorphic over isotic, frigid Alfic Udivitrands

TYPICAL PEDON: Tamara ashy silt loam, woodland, on a 20 percent east-facing slope at an elevation of 4,660 feet. (Colors are for moist soil unless otherwise noted.)

TOMMYCORK SERIES

The Tommycork series consists of moderately deep, well drained soils on backslopes of dissected basalt plateaus. Tommycork soils formed in colluvium from basalt with loess and a small amount of volcanic ash in surface horizons. Slopes are 0 to 60 percent. Mean annual precipitation is about 19 inches and mean annual temperature about 43 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Vitrandic Argixerolls

TYPICAL PEDON: Tommycork ashy silt loam - rangeland, on a 2 percent north facing slope at an elevation of 4,100 feet.

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## Subsoiling Prescription:

**TEMPORARY ROADS & OTHER SOIL COMPACTION ON VARIOUS SLOPES AND SOIL CONDITIONS - Thomas Creek Restoration Project**

**PHYSICAL CONDITIONS**

Proposed for use during harvest activities in the Thomas Creek project are “existing” temporary roads and created temporary roads. Though the name “existing” temporary roads seems to be an error, it describes remnant legacy trails and roads; left to recover via natural processes (passive restoration). Unfortunately the anticipated recovery did not occur, leaving the legacy impacts on the landscape.

All estimates of area are the known distance of proposed roads and an assumed width of temporary road, (distance of road (ft.) * 12ft width = Acres) actual locations are identified in table 1. Actual width of these roads may vary + 3 feet along various segments of roads/trails from variation in traffic impacts. The variation in traffic impacts are from forest visitor use around fallen trees or other traffic obstructions. The following sections of this document segregate current and proposed road/trails to estimate the current impacts on the landscape. Any variation of treatment is to be based upon anticipated soil depth alone. All treatments will receive the addition of slash to amend the soil of both existing and proposed temporary roads/trails.

**Table 9 Soil Depth as an indicator of restoration opportunity.**

| SOIL DEPTH: INDICATOR OF SUBSOILING OPPERTUNTIY | | | | | |
|---|---|---|---|---|---|
| | | Soil 2 | | | |
| | | Shallow (<20”) | Moderately Deep (20”-40”) | Deep (40”-60”) | Very Deep (>60”) |
| Soil 1 | Shallow (<20”) | Scarify | Scarify | Scarify or Subsoil | Scarify or Subsoil |
| | Mod. Deep (20”-40”) | Scarify or Subsoil | Scarify or Subsoil | Scarify or Subsoil | Scarify or Subsoil |
| | Deep (40”-60”) | Scarify or Subsoil | Subsoil | Subsoil | Subsoil |
| | Very Deep (>60”) | Subsoil | Subsoil | Subsoil | Subsoil |

In **Error! Reference source not found.**, Soil 1 and soil 2 are first and second soil named in the mapped oil complex for the area in being examined. Soil depth is based on NRCS criteria.

**Table 10 Proposed obliteration equipment for temporary roads.**

| SOIL ROCK CONTENT (0 to 15inches): INDICATOR OF EQUIPMENT SUITED TO OBLITERATE TEMPORARY ROADS | | | | | |
|---|---|---|---|---|---|
| | | Soil 2 has: | | | |
| | | 60% to 45% rock | 44% to 30% rock | 29% to 5% rock | 4% to <1% rock |
| Soil 1 | 60% to 45% rock | Excavator | Excavator | Excavator | Excavator or Dozer |
| | 44% to 30% rock | Excavator | Excavator | Excavator | Excavator or Dozer |
| | 29% to 5% rock | Excavator or Dozer | Excavator or Dozer | Excavator or Dozer | Excavator or Dozer |
| | 4% to <1% rock | Excavator or Dozer | Excavator or Dozer | Excavator or Dozer | Excavator or Dozer |

In Table 10, when obliteration is prescribed and which equipment that is most likely to achieve best overall results when considering temporary road spatial location; with rock content of mapped soils

**EXISTING TEMPORARY ROAD CONDITIONS**

The use of the term temporary road in this case is erroneous, since temporary implies these roads will not remain on the landscape. Due to various environmental factors passive restoration did not take place; therefore these obliteration treatments are deemed necessary to ensure the use of temporary roads will indeed be temporary. Locating these roads/trails has been possible by identifying berms and/or wheel ruts consistent with roads, either from field observations or from remote sensing (Aerial Photographs).

**TREATMENT OF CREATED OR LEGACY SOIL COMPACTION**

The presence of legacy compaction (existing temporary roads) within the proposed activity area is the reason for subsoiling all temporary roads utilized within the Thomas Creek project proposal. Location of specific roads are mapped and identified in GIS in the Thomas Creek project folder. In addition to removal of temporary roads, any temporary landing will also receive the same subsoiling treatment as its associated temporary road.

**Ridge Top Roads**

The soil conditions associated with these roads are typically a shallow in soil depth (some occurrence of moderately deep soil may be present).

1. If soil is to a depth >20 inches, subsoiling will be to a depth of at least 20 inches.
    a. If bedrock is <20 inches surface, scarification will be to the lithic (rock) contact or at least 10 inches.
2. Effective Ground Cover (EGC) for all subsoiling treatments is a requirement. Where available EGC will take advantage of harvest create slash. If no suitable organic material is available, then use of certified weed-free straw is appropriate.
    a. Stabilization of soil surface with Slash (or organic material) is done to prevent resulting subsoiling treatment from soil crusting conditions. Crusting can inhibit moisture infiltration and promote erosion (Luce 1997).

**Mid-slope Roads**

The soil conditions associated with these roads are typically a moderately deep to deep soil; depending upon associated geology and road fill depths.

1. If soil is to a depth >20 inches, subsoiling will be to a depth of at least 20 inches.
    a. If bedrock is <20 inches surface, scarification will be to the lithic (rock) contact or at least 10 inches.
2. If there is a need to restore hillside hydrology by re-contouring the road; subsoiling will be limited to the compacted roadbed not excavated during re-contouring.
3. Effective Ground Cover (EGC) for all subsoiling treatments is a requirement. Materials used for EGC will take advantage of available harvest slash. If no suitable organic material is available, then use of certified weed-free straw is appropriate.
    a. Stabilization of soil surface with Slash (or organic material) is done to prevent resulting subsoiling treatment from soil crusting conditions. Crusting can inhibit moisture infiltration and promote erosion (Luce 1997).

**Toe Slope and/or Gentle Topography roads**

The soil conditions associated with these roads can vary from deep soil in Toe slopes; to varying depth (shallow to very deep) in gentle topography.

1. If soil is to a depth >20 inches, subsoiling will be to a depth of at least 20 inches.
    a. If bedrock is <20 inches surface, scarification will be to the lithic (rock) contact or at least 10 inches.

2. Effective Ground Cover (EGC) for all subsoiling treatments is a requirement. Materials used for EGC will take advantage of available harvest slash. If no suitable organic material is available, then use of certified weed-free straw is appropriate.

    a. Stabilization of soil surface with Slash (or organic material) is done to prevent resulting subsoiling treatment from soil crusting conditions. Crusting can inhibit moisture infiltration and promote erosion (Luce 1997).

Equipment for Subsoiling Activities: Benefits and prescriptive limits for each

**Dozer:** Rear mounted winged subsoiling shanks are the only dozer mounted option to be considered  If project does not have adequate EGC component, then dozer subsoiling may be considered best economic value to for work. However for the above prescription dozer equipment alone is not the best suited for easy completion of all aspects of the above subsoiling prescription.

**Benefits**

1. Subsoiling operation done with the greatest speed.
2. Some implements are built and well suited for use in areas with minimal trees.

**Prescriptive Limits**

1. Operator is not in constant visual contact with work activity.
    a. Can cause subsurface rock and boulders to be brought to the surface in some cases.
    b. Subsoiling with a dozer can lead to vegetation accumulations in equipment that will leave exposed soil from displaced vegetation.
    c. Fuels Specialist may consider displaced vegetation concentrations, a fuel hazard.
    d. Subsoiling can damage retained tree roots, since operator may not always be aware of implement actions as they concentrate on driving the dozer.
2. Dozer subsoiling forms linear patterns, sometimes leaving subsoiling furrows.
    a. Subsoiling furrows can offers the least desired amount of microsite conditions for seeds and seedling plants and create un-natural appearance of planted furrows; even if only seeds from soil seed bank sprout.
    b. If treatment lacks EGC and soil lacks Organic Matter (OM or harvest debris), this may lead to soil crusting that can cause the soil surface to seal; followed by accelerated erosion (Luce 1997).
3. All subsoiling activities will require use some form of EGC. When harvest debris is not available, straw (or other OM) will be required. Due to the operational limitations of the dozer, this may require hand crew application of EGC following subsoiling.

**Excavator (approximately a Cat 200LC or Log Loader)** without the aid of any specialized subsoiling attachments. Equipment is not the best suited for easy completion of all aspects of the above subsoiling prescription.

**Benefits**

1. Operator is in constant visual contact with work activity.
    a. Therefore, they are aware of subsurface obstructions and prevent damage to trees, equipment or bring large boulders and rocks to the surface.
2. Work can be done concurrently with machine piling project work, thus could be a cost effective means of accomplishing both machine piling and subsoiling compacted soils like temporary roads.
3. Subsoiling & Grapple Piling work is accomplished from a single work. (See Figure 2).
4. Excavator is able to take advantage of surrounding harvest slash for use as EGC. When OM (Harvest Slash) is not available, straw (or other OM) will be required. The excavator has the operational ability to apply EGC following subsoiling, without needing a hand crew.
5. Some operators have retrofitted their logging equipment to meet the needs of this prescription and have accomplished similar results to the specialized equipment mentioned in the next excavator example.

**Prescriptive Limits**

1. Excavator subsoiling operations has the slowest completion rate when using a bucket alone to subsoil.
    a. Because, the excavator accomplishes subsoiling by entering the soil with the bucket as if to excavate, curling in the bucket to break compaction without rising from the ground. The buckets action is then reversed to exit the soil without mixing the soil profiles (i.e. horizons). Treatment area is little more than the area in contact with the bucket.
    b. The excavator may use an un-attached subsoiling implement to achieve defined work, by holding implement between excavator thumb and bucket.
        i. Improved rate of work, but still has problems with retaining implement in a proper position for subsoiling. Over time this can also damage subsoiling implements not constructed for use in this fashion.
2. When operating in grassed locations with widely spaced trees, the rate of accomplishment is low when compared to dozer work.

**Excavator (i.e. ~ Cat 200LC): with a specialized subsoiling attachment**. This equipment is best suited for easy completion of all aspects of the above subsoiling prescription.

**Benefits**

1. Specialized subsoiling attachments can be a Subsoiling Grapple Rake (Archuleta and Karr 2006) or a Subsoiling Excavator Bucket (Archuleta and Karr 2006), or other suitable implement.
    a. Operator is in constant visual contact with work activity.

i. Therefore, they are aware of subsurface obstructions and prevent damage to equipment or surfacing of large boulders and rocks.

b. Subsoiling operation with this implement has an improved rate of completion over other excavator subsoiling methods.

i. This method is still slower than dozer subsoiling, but when considering the fast application of EGC; the total project time is faster than dozer work.

c. The excavator accomplishes subsoiling by; rotating head into subsoiling mode (see Figure 1). Subsoiling occurs from a single stationary work position (see Figure 2), then excavator moves to new position and process.

d. EGC is placed when implement is placed into grapple rake mode for placement of EGC (see figure 2).

2. Work can be done concurrently with machine piling project work, thus could be a cost effective means of accomplishing both machine piling and subsoiling compacted soils like temporary roads.

3. Excavator is able to take advantage of surrounding harvest slash for use as EGC. When OM (Harvest Slash) is not available, straw (or other OM) will be required. The excavator has the operational ability to apply EGC following subsoiling, without needing a hand crew.

**Prescriptive Limits**

1. When operating in grassed locations with widely spaced trees, the rate of accomplishment is low when compared to dozer work, since tightly spaced stumps limits the speed of dozer subsoiling. Areas with tightly spaced stumps that limit equipment are also likely to not have been compacted in the first place.

## Analysis Data Tables:

**Table 11 Criteria for equipment trails in or around Class 3 & 4 stream RHCAs[4].**

| | Sediment Buffer Width | | Activity Area | | Max Trail distance or activity allowed |
|---|---|---|---|---|---|
| A | First 100ft from stream edge has a slope between 0%-20% | Yes | Activity Area Slope < 35% or >35%? | <35% | 600ft[5] |
| | | | | >35% | Only Non-Ground Based Harvest and Prescribed Fire |
| | | No | Go to B or C | | |
| B | First 75ft from stream edge has a slope between 21%-35% | Yes | Activity Area Slope < 35% or >35%? | <35% | 225ft[5] |
| | | No | | >35% | Only Non-Ground Based Harvest and Prescribed Fire |
| C | 35% or more | Yes | | | Only Non-Ground Based Harvest and Prescribed Fire |

**Table 12 WEPP Data inputs and Results**

| WEPP Run Combo | Soil Texture | Upper Element = Treatment [6] | Upper Gradient (%) 1 | Upper Gradient (%) 2 | Upper Horizontal Length (ft.) | Upper Cover (%) | Upper Rock (%) | Lower Element = Buffer[6] | Lower Gradient (%) 1 | Lower Gradient (%) 2 | Lower Horizontal Length (ft.) | Lower Cover (%) | Lower Rock (%) | Delivery (30 years) t/ac | Probability of delivery | Delivery Average t/ac | Activity Cleared [7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Harvest Scenario (Loam) | | | | | | | | | | | | | | | | | |
| 1 | loam | PG | 60 | 60 | 1150 | 40 | 10 | MF | 40 | 5 | 50 | 100 | 10 | 0.0 | 10% | 0.0 | Harvest |
| 2 | loam | PG | 60 | 60 | 1175 | 40 | 10 | MF | 40 | 5 | 25 | 100 | 10 | 0.0 | 10% | 0.0 | Harvest |
| 3 | loam | PG | 60 | 60 | 1195 | 40 | 10 | MF | 40 | 5 | 5 | 100 | 10 | 0.2 | 10% | 0.0 | Harvest |
| 4 | loam | PG | 60 | 60 | 1150 | 40 | 10 | MF | 50 | 5 | 50 | 100 | 10 | 0.0 | 10% | 0.0 | Harvest |
| 5 | loam | PG | 60 | 60 | 1175 | 40 | 10 | MF | 50 | 5 | 25 | 100 | 10 | 0.0 | 10% | 0.0 | Harvest |
| 6 | loam | PG | 60 | 60 | 1195 | 40 | 10 | MF | 50 | 5 | 5 | 100 | 10 | 0.2 | 10% | 0.0 | Harvest |
| 7 | loam | PG | 60 | 60 | 1150 | 40 | 10 | MF | 60 | 5 | 50 | 100 | 10 | 0.0 | 10% | 0.0 | Harvest |
| 8 | loam | PG | 60 | 60 | 1175 | 40 | 10 | MF | 60 | 5 | 25 | 100 | 10 | 0.1 | 10% | 0.0 | Harvest |
| 9 | loam | PG | 60 | 60 | 1195 | 40 | 10 | MF | 60 | 5 | 5 | 100 | 10 | 0.2 | 10% | 0.0 | Harvest |
| 10 | loam | MF | 60 | 60 | 1150 | 100 | 10 | MF | 40 | 5 | 50 | 100 | 10 | 0.0 | 0% | 0.0 | Harvest |
| 11 | loam | MF | 60 | 60 | 1150 | 100 | 10 | MF | 50 | 5 | 50 | 100 | 10 | 0.0 | 0% | 0.0 | Harvest |

[4] Limits are based on WEPP results.
[5] Maximum distance of trail unless the slope is broken by topography or water bars.
[6] WEPP Treatment Codes: PG - Poor Grass (40%, EGC), MF - Mature Forest (100% EGC), ST - Skid Trail (10% EGC), HSF- High Severity Fire (45% EGC)
[7] Cell contains logic formula (=if(Delivery Average t/ac<0.03t/ac, True="Harvest" or "Trail", False="No Harvest" or "No Trail")

| WEPP Run Combo | Soil Texture | Upper Element = Treatment [6] | Upper Gradient (%) 1 | Upper Gradient (%) 2 | Upper Horizontal Length (ft.) | Upper Cover (%) | Upper Rock (%) | Lower Element = Buffer [6] | Lower Gradient (%) 1 | Lower Gradient (%) 2 | Lower Horizontal Length (ft.) | Lower Cover (%) | Lower Rock (%) | Delivery (30 years) t/ac | Probability of delivery | Delivery Average t/ac | Activity Cleared [7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | loam | MF | 60 | 60 | 1150 | 100 | 10 | MF | 60 | 5 | 50 | 100 | 10 | 0.0 | 0% | 0.0 | Harvest |
| Harvest Scenario (Silt Loam) | | | | | | | | | | | | | | | | | |
| 1 | silt-loam | PG | 60 | 60 | 1150 | 40 | 10 | MF | 40 | 5 | 50 | 100 | 10 | 0.0 | 10% | 0.0 | Harvest |
| 2 | silt-loam | PG | 60 | 60 | 1175 | 40 | 10 | MF | 40 | 5 | 25 | 100 | 10 | 0.1 | 13% | 0.0 | Harvest |
| 3 | silt-loam | PG | 60 | 60 | 1195 | 40 | 10 | MF | 40 | 5 | 5 | 100 | 10 | 0.4 | 13% | 0.0 | Harvest |
| 4 | silt-loam | PG | 60 | 60 | 1150 | 40 | 10 | MF | 50 | 5 | 50 | 100 | 10 | 0.0 | 10% | 0.0 | Harvest |
| 5 | silt-loam | PG | 60 | 60 | 1175 | 40 | 10 | MF | 50 | 5 | 25 | 100 | 10 | 0.1 | 13% | 0.0 | Harvest |
| 6 | silt-loam | PG | 60 | 60 | 1195 | 40 | 10 | MF | 50 | 5 | 5 | 100 | 10 | 0.4 | 13% | 0.0 | Harvest |
| 7 | silt-loam | PG | 60 | 60 | 1150 | 40 | 10 | MF | 60 | 5 | 50 | 100 | 10 | 0.0 | 10% | 0.0 | Harvest |
| 8 | silt-loam | PG | 60 | 60 | 1175 | 40 | 10 | MF | 60 | 5 | 25 | 100 | 10 | 0.1 | 13% | 0.0 | Harvest |
| 9 | silt-loam | PG | 60 | 60 | 1195 | 40 | 10 | MF | 60 | 5 | 5 | 100 | 10 | 0.5 | 13% | 0.0 | Harvest |
| 10 | silt-loam | MF | 60 | 60 | 1150 | 100 | 10 | MF | 40 | 5 | 50 | 100 | 10 | 0.1 | 3% | 0.0 | Harvest |
| 11 | silt-loam | MF | 60 | 60 | 1150 | 100 | 10 | MF | 50 | 5 | 50 | 100 | 10 | 0.1 | 3% | 0.0 | Harvest |
| 12 | silt-loam | MF | 60 | 60 | 1150 | 100 | 10 | MF | 60 | 5 | 50 | 100 | 10 | 0.1 | 3% | 0.0 | Harvest |
| Skid Trail Scenario (Loam) | | | | | | | | | | | | | | | | | |
| 1 | Loam | ST | 35 | 35 | 695 | 10 | 10 | MF | 10 | 5 | 5 | 100 | 10 | 6.0 | 67% | 0.7 | No Trail |
| 2 | Loam | ST | 35 | 35 | 675 | 10 | 10 | MF | 10 | 5 | 25 | 100 | 10 | 4.1 | 43% | 0.2 | No Trail |
| 3 | Loam | ST | 35 | 35 | 650 | 10 | 10 | MF | 10 | 5 | 50 | 100 | 10 | 2.4 | 30% | 0.1 | No Trail |
| 4 | Loam | ST | 35 | 35 | 625 | 10 | 10 | MF | 10 | 5 | 75 | 100 | 10 | 1.0 | 20% | 0.0 | No Trail |
| 5 | Loam | ST | 35 | 35 | 600 | 10 | 10 | MF | 10 | 5 | 100 | 100 | 10 | 0.3 | 10% | 0.0 | Trail |
| 6 | Loam | ST | 35 | 35 | 695 | 10 | 10 | MF | 20 | 5 | 5 | 100 | 10 | 6.4 | 67% | 0.8 | No Trail |
| 7 | Loam | ST | 35 | 35 | 675 | 10 | 10 | MF | 20 | 5 | 25 | 100 | 10 | 4.8 | 43% | 0.3 | No Trail |
| 8 | Loam | ST | 35 | 35 | 650 | 10 | 10 | MF | 20 | 5 | 50 | 100 | 10 | 3.4 | 33% | 0.2 | No Trail |
| 9 | Loam | ST | 35 | 35 | 625 | 10 | 10 | MF | 20 | 5 | 75 | 100 | 10 | 1.8 | 20% | 0.1 | No Trail |
| 10 | Loam | ST | 35 | 35 | 600 | 10 | 10 | MF | 20 | 5 | 100 | 100 | 10 | 0.6 | 13% | 0.0 | Trail |
| 11 | Loam | ST | 35 | 35 | 695 | 10 | 10 | MF | 30 | 5 | 5 | 100 | 10 | 6.6 | 67% | 0.9 | No Trail |
| 12 | Loam | ST | 35 | 35 | 675 | 10 | 10 | MF | 30 | 5 | 25 | 100 | 10 | 5.9 | 53% | 0.4 | No Trail |
| 13 | Loam | ST | 35 | 35 | 650 | 10 | 10 | MF | 30 | 5 | 50 | 100 | 10 | 3.9 | 40% | 0.2 | No Trail |
| 14 | Loam | ST | 35 | 35 | 625 | 10 | 10 | MF | 30 | 5 | 75 | 100 | 10 | 2.6 | 33% | 0.1 | No Trail |
| 15 | Loam | ST | 35 | 35 | 600 | 10 | 10 | MF | 30 | 5 | 100 | 100 | 10 | 1.0 | 17% | 0.0 | No Trail |
| 16 | Loam | ST | 35 | 35 | 695 | 10 | 10 | MF | 40 | 5 | 5 | 100 | 10 | 6.9 | 67% | 0.9 | No Trail |
| 17 | Loam | ST | 35 | 35 | 675 | 10 | 10 | MF | 40 | 5 | 25 | 100 | 10 | 6.4 | 57% | 0.5 | No Trail |
| 18 | Loam | ST | 35 | 35 | 650 | 10 | 10 | MF | 40 | 5 | 50 | 100 | 10 | 4.6 | 40% | 0.3 | No Trail |
| 19 | Loam | ST | 35 | 35 | 625 | 10 | 10 | MF | 40 | 5 | 75 | 100 | 10 | 3.2 | 33% | 0.2 | No Trail |

| WEPP Run Combo | Soil Texture | Upper Element = Treatment [6] | Upper Gradient (%) 1 | Upper Gradient (%) 2 | Upper Horizontal Length (ft.) | Upper Cover (%) | Upper Rock (%) | Lower Element = Buffer [6] | Lower Gradient (%) 1 | Lower Gradient (%) 2 | Lower Horizontal Length (ft.) | Lower Cover (%) | Lower Rock (%) | Delivery (30 years) t/ac | Probability of delivery | Delivery Average t/ac | Activity Cleared [7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | Loam | ST | 35 | 35 | 600 | 10 | 10 | MF | 40 | 5 | 100 | 100 | 10 | 1.4 | 20% | 0.1 | No Trail |
| 21 | Loam | ST | 35 | 35 | 295 | 10 | 10 | MF | 10 | 5 | 5 | 100 | 10 | 2.9 | 67% | 0.4 | No Trail |
| 22 | Loam | ST | 35 | 35 | 275 | 10 | 10 | MF | 10 | 5 | 25 | 100 | 10 | 1.7 | 27% | 0.1 | No Trail |
| 23 | Loam | ST | 35 | 35 | 250 | 10 | 10 | MF | 10 | 5 | 50 | 100 | 10 | 0.3 | 10% | 0.0 | Trail |
| 24 | Loam | ST | 35 | 35 | 225 | 10 | 10 | MF | 10 | 5 | 75 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 25 | Loam | ST | 35 | 35 | 200 | 10 | 10 | MF | 10 | 5 | 100 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 26 | Loam | ST | 35 | 35 | 295 | 10 | 10 | MF | 20 | 5 | 5 | 100 | 10 | 3.1 | 67% | 0.4 | No Trail |
| 27 | Loam | ST | 35 | 35 | 275 | 10 | 10 | MF | 20 | 5 | 25 | 100 | 10 | 2.2 | 33% | 0.1 | No Trail |
| 28 | Loam | ST | 35 | 35 | 250 | 10 | 10 | MF | 20 | 5 | 50 | 100 | 10 | 0.4 | 10% | 0.0 | Trail |
| 29 | Loam | ST | 35 | 35 | 225 | 10 | 10 | MF | 20 | 5 | 75 | 100 | 10 | 0.1 | 7% | 0.0 | Trail |
| 30 | Loam | ST | 35 | 35 | 200 | 10 | 10 | MF | 20 | 5 | 100 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 31 | Loam | ST | 35 | 35 | 295 | 10 | 10 | MF | 30 | 5 | 5 | 100 | 10 | 3.2 | 67% | 0.5 | No Trail |
| 32 | Loam | ST | 35 | 35 | 275 | 10 | 10 | MF | 30 | 5 | 25 | 100 | 10 | 2.4 | 37% | 0.2 | No Trail |
| 33 | Loam | ST | 35 | 35 | 250 | 10 | 10 | MF | 30 | 5 | 50 | 100 | 10 | 0.9 | 17% | 0.0 | No Trail |
| 34 | Loam | ST | 35 | 35 | 225 | 10 | 10 | MF | 30 | 5 | 75 | 100 | 10 | 0.1 | 10% | 0.0 | Trail |
| 35 | Loam | ST | 35 | 35 | 200 | 10 | 10 | MF | 30 | 5 | 100 | 100 | 10 | 0.1 | 7% | 0.0 | Trail |
| 36 | Loam | ST | 35 | 35 | 295 | 10 | 10 | MF | 40 | 5 | 5 | 100 | 10 | 3.3 | 67% | 0.5 | No Trail |
| 37 | Loam | ST | 35 | 35 | 275 | 10 | 10 | MF | 40 | 5 | 25 | 100 | 10 | 2.6 | 37% | 0.2 | No Trail |
| 38 | Loam | ST | 35 | 35 | 250 | 10 | 10 | MF | 40 | 5 | 50 | 100 | 10 | 1.1 | 17% | 0.0 | No Trail |
| 39 | Loam | ST | 35 | 35 | 225 | 10 | 10 | MF | 40 | 5 | 75 | 100 | 10 | 0.2 | 10% | 0.0 | Trail |
| 40 | Loam | ST | 35 | 35 | 200 | 10 | 10 | MF | 40 | 5 | 100 | 100 | 10 | 0.1 | 7% | 0.0 | Trail |
| 41 | Loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 10 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 42 | Loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 20 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 43 | Loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 30 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 44 | Loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 40 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 45 | Loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 50 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 46 | Loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 60 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 47 | Loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 10 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 48 | Loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 20 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 49 | Loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 30 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 50 | Loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 40 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 51 | Loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 50 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 52 | Loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 60 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| Skid Trail Scenario (Silt Loam) | | | | | | | | | | | | | | | | | |

| WEPP Run Combo | Soil Texture | Upper Element = Treatment [6] | Upper Gradient (%) 1 | Upper Gradient (%) 2 | Upper Horizontal Length (ft.) | Upper Cover (%) | Upper Rock (%) | Lower Element = Buffer [6] | Lower Gradient (%) 1 | Lower Gradient (%) 2 | Lower Horizontal Length (ft.) | Lower Cover (%) | Lower Rock (%) | Delivery (30 years) t/ac | Probability of delivery | Delivery Average t/ac | Activity Cleared [7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | silt-loam | ST | 35 | 35 | 695 | 10 | 10 | MF | 10 | 5 | 5 | 100 | 10 | 6.3 | 33% | 0.5 | No Trail |
| 2 | silt-loam | ST | 35 | 35 | 675 | 10 | 10 | MF | 10 | 5 | 25 | 100 | 10 | 3.5 | 27% | 0.2 | No Trail |
| 3 | silt-loam | ST | 35 | 35 | 650 | 10 | 10 | MF | 10 | 5 | 50 | 100 | 10 | 1.1 | 20% | 0.0 | No Trail |
| 4 | silt-loam | ST | 35 | 35 | 625 | 10 | 10 | MF | 10 | 5 | 75 | 100 | 10 | 0.5 | 13% | 0.0 | Trail |
| 5 | silt-loam | ST | 35 | 35 | 600 | 10 | 10 | MF | 10 | 5 | 100 | 100 | 10 | 0.3 | 10% | 0.0 | Trail |
| 6 | silt-loam | ST | 35 | 35 | 695 | 10 | 10 | MF | 20 | 5 | 5 | 100 | 10 | 6.3 | 33% | 0.5 | No Trail |
| 7 | silt-loam | ST | 35 | 35 | 675 | 10 | 10 | MF | 20 | 5 | 25 | 100 | 10 | 3.5 | 27% | 0.2 | No Trail |
| 8 | silt-loam | ST | 35 | 35 | 650 | 10 | 10 | MF | 20 | 5 | 50 | 100 | 10 | 1.1 | 20% | 0.0 | No Trail |
| 9 | silt-loam | ST | 35 | 35 | 625 | 10 | 10 | MF | 20 | 5 | 75 | 100 | 10 | 0.5 | 13% | 0.0 | Trail |
| 10 | silt-loam | ST | 35 | 35 | 600 | 10 | 10 | MF | 20 | 5 | 100 | 100 | 10 | 0.3 | 10% | 0.0 | Trail |
| 11 | silt-loam | ST | 35 | 35 | 695 | 10 | 10 | MF | 30 | 5 | 5 | 100 | 10 | 6.3 | 33% | 0.5 | No Trail |
| 12 | silt-loam | ST | 35 | 35 | 675 | 10 | 10 | MF | 30 | 5 | 25 | 100 | 10 | 3.5 | 27% | 0.2 | No Trail |
| 13 | silt-loam | ST | 35 | 35 | 650 | 10 | 10 | MF | 30 | 5 | 50 | 100 | 10 | 1.1 | 20% | 0.0 | No Trail |
| 14 | silt-loam | ST | 35 | 35 | 625 | 10 | 10 | MF | 30 | 5 | 75 | 100 | 10 | 0.5 | 13% | 0.0 | Trail |
| 15 | silt-loam | ST | 35 | 35 | 600 | 10 | 10 | MF | 30 | 5 | 100 | 100 | 10 | 0.3 | 10% | 0.0 | Trail |
| 16 | silt-loam | ST | 35 | 35 | 695 | 10 | 10 | MF | 40 | 5 | 5 | 100 | 10 | 6.3 | 33% | 0.5 | No Trail |
| 17 | silt-loam | ST | 35 | 35 | 675 | 10 | 10 | MF | 40 | 5 | 25 | 100 | 10 | 3.5 | 27% | 0.2 | No Trail |
| 18 | silt-loam | ST | 35 | 35 | 650 | 10 | 10 | MF | 40 | 5 | 50 | 100 | 10 | 1.1 | 20% | 0.0 | No Trail |
| 19 | silt-loam | ST | 35 | 35 | 625 | 10 | 10 | MF | 40 | 5 | 75 | 100 | 10 | 0.5 | 13% | 0.0 | Trail |
| 20 | silt-loam | ST | 35 | 35 | 600 | 10 | 10 | MF | 40 | 5 | 100 | 100 | 10 | 0.3 | 10% | 0.0 | Trail |
| 21 | silt-loam | ST | 35 | 35 | 295 | 10 | 10 | MF | 10 | 5 | 5 | 100 | 10 | 3.2 | 33% | 0.3 | No Trail |
| 22 | silt-loam | ST | 35 | 35 | 275 | 10 | 10 | MF | 10 | 5 | 25 | 100 | 10 | 1.3 | 17% | 0.1 | No Trail |
| 23 | silt-loam | ST | 35 | 35 | 250 | 10 | 10 | MF | 10 | 5 | 50 | 100 | 10 | 0.3 | 7% | 0.0 | Trail |
| 24 | silt-loam | ST | 35 | 35 | 225 | 10 | 10 | MF | 10 | 5 | 75 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 25 | silt-loam | ST | 35 | 35 | 200 | 10 | 10 | MF | 10 | 5 | 100 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 26 | silt-loam | ST | 35 | 35 | 295 | 10 | 10 | MF | 20 | 5 | 5 | 100 | 10 | 3.5 | 33% | 0.3 | No Trail |
| 27 | silt-loam | ST | 35 | 35 | 275 | 10 | 10 | MF | 20 | 5 | 25 | 100 | 10 | 1.9 | 17% | 0.1 | No Trail |
| 28 | silt-loam | ST | 35 | 35 | 250 | 10 | 10 | MF | 20 | 5 | 50 | 100 | 10 | 0.6 | 10% | 0.0 | Trail |
| 29 | silt-loam | ST | 35 | 35 | 225 | 10 | 10 | MF | 20 | 5 | 75 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 30 | silt-loam | ST | 35 | 35 | 200 | 10 | 10 | MF | 20 | 5 | 100 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 31 | silt-loam | ST | 35 | 35 | 295 | 10 | 10 | MF | 30 | 5 | 5 | 100 | 10 | 3.6 | 33% | 0.3 | No Trail |
| 32 | silt-loam | ST | 35 | 35 | 275 | 10 | 10 | MF | 30 | 5 | 25 | 100 | 10 | 2.3 | 17% | 0.1 | No Trail |
| 33 | silt-loam | ST | 35 | 35 | 250 | 10 | 10 | MF | 30 | 5 | 50 | 100 | 10 | 0.8 | 10% | 0.0 | No Trail |
| 34 | silt-loam | ST | 35 | 35 | 225 | 10 | 10 | MF | 30 | 5 | 75 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |

| WEPP Run Combo | Soil Texture | Upper Element = Treatment [6] | Upper Gradient (%) 1 | Upper Gradient (%) 2 | Upper Horizontal Length (ft.) | Upper Cover (%) | Upper Rock (%) | Lower Element = Buffer [6] | Lower Gradient (%) 1 | Lower Gradient (%) 2 | Lower Horizontal Length (ft.) | Lower Cover (%) | Lower Rock (%) | Delivery (30 years) t/ac | Probability of delivery | Delivery Average t/ac | Activity Cleared [7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | silt-loam | ST | 35 | 35 | 200 | 10 | 10 | MF | 30 | 5 | 100 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 36 | silt-loam | ST | 35 | 35 | 295 | 10 | 10 | MF | 40 | 5 | 5 | 100 | 10 | 3.8 | 33% | 0.3 | No Trail |
| 37 | silt-loam | ST | 35 | 35 | 275 | 10 | 10 | MF | 40 | 5 | 25 | 100 | 10 | 2.5 | 17% | 0.1 | No Trail |
| 38 | silt-loam | ST | 35 | 35 | 250 | 10 | 10 | MF | 40 | 5 | 50 | 100 | 10 | 0.9 | 10% | 0.0 | No Trail |
| 39 | silt-loam | ST | 35 | 35 | 225 | 10 | 10 | MF | 40 | 5 | 75 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 40 | silt-loam | ST | 35 | 35 | 200 | 10 | 10 | MF | 40 | 5 | 100 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 41 | silt-loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 10 | 5 | 5 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 42 | silt-loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 20 | 5 | 5 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 43 | silt-loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 30 | 5 | 5 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 44 | silt-loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 40 | 5 | 5 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 45 | silt-loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 50 | 5 | 5 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 46 | silt-loam | MF | 35 | 35 | 695 | 100 | 10 | MF | 60 | 5 | 5 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 47 | silt-loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 10 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 48 | silt-loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 20 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 49 | silt-loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 30 | 5 | 5 | 100 | 10 | 0.0 | 0% | 0.0 | Trail |
| 50 | silt-loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 40 | 5 | 5 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 51 | silt-loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 50 | 5 | 5 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |
| 52 | silt-loam | MF | 35 | 35 | 295 | 100 | 10 | MF | 60 | 5 | 5 | 100 | 10 | 0.0 | 3% | 0.0 | Trail |

Wildfire Scenario (Loam)

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | loam | PG | 60 | 60 | 1150 | 40 | 10 | HSF | 40 | 5 | 50 | 100 | 10 | 0.3 | 23% | 0.0 | Harvest |
| 2 | loam | PG | 60 | 60 | 1175 | 40 | 10 | HSF | 40 | 5 | 25 | 100 | 10 | 0.3 | 23% | 0.0 | Harvest |
| 3 | loam | PG | 60 | 60 | 1195 | 40 | 10 | HSF | 40 | 5 | 5 | 100 | 10 | 0.3 | 23% | 0.0 | Harvest |
| 4 | loam | PG | 60 | 60 | 1150 | 40 | 10 | HSF | 50 | 5 | 50 | 100 | 10 | 0.3 | 23% | 0.0 | Harvest |
| 5 | loam | PG | 60 | 60 | 1175 | 40 | 10 | HSF | 50 | 5 | 25 | 100 | 10 | 0.3 | 23% | 0.0 | Harvest |
| 6 | loam | PG | 60 | 60 | 1195 | 40 | 10 | HSF | 50 | 5 | 5 | 100 | 10 | 0.3 | 23% | 0.0 | Harvest |
| 7 | loam | PG | 60 | 60 | 1150 | 40 | 10 | HSF | 60 | 5 | 50 | 100 | 10 | 0.3 | 23% | 0.0 | Harvest |
| 8 | loam | PG | 60 | 60 | 1175 | 40 | 10 | HSF | 60 | 5 | 25 | 100 | 10 | 0.3 | 23% | 0.0 | Harvest |
| 9 | loam | PG | 60 | 60 | 1195 | 40 | 10 | HSF | 60 | 5 | 5 | 100 | 10 | 0.3 | 23% | 0.0 | Harvest |

Wildfire Scenario (Silt Loam)

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | silt-loam | PG | 60 | 60 | 1150 | 40 | 10 | HSF | 40 | 5 | 50 | 45 | 10 | 0.1 | 10% | 0.0 | Harvest |
| 2 | silt-loam | PG | 60 | 60 | 1175 | 40 | 10 | HSF | 40 | 5 | 25 | 45 | 10 | 0.1 | 10% | 0.0 | Harvest |
| 3 | silt-loam | PG | 60 | 60 | 1195 | 40 | 10 | HSF | 40 | 5 | 5 | 45 | 10 | 0.1 | 10% | 0.0 | Harvest |
| 4 | silt-loam | PG | 60 | 60 | 1150 | 40 | 10 | HSF | 50 | 5 | 50 | 45 | 10 | 0.1 | 10% | 0.0 | Harvest |
| 5 | silt-loam | PG | 60 | 60 | 1175 | 40 | 10 | HSF | 50 | 5 | 25 | 45 | 10 | 0.1 | 10% | 0.0 | Harvest |

| WEPP Run Combo | Soil Texture | Upper Element = Treatment [6] | Upper Gradient (%) 1 | Upper Gradient (%) 2 | Upper Horizontal Length (ft.) | Upper Cover (%) | Upper Rock (%) | Lower Element = Buffer[6] | Lower Gradient (%) 1 | Lower Gradient (%) 2 | Lower Horizontal Length (ft.) | Lower Cover (%) | Lower Rock (%) | Delivery (30 years) t/ac | Probability of delivery | Delivery Average t/ac | Activity Cleared [7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | silt-loam | PG | 60 | 60 | 1195 | 40 | 10 | HSF | 50 | 5 | 5 | 45 | 10 | 0.1 | 10% | 0.0 | Harvest |
| 7 | silt-loam | PG | 60 | 60 | 1150 | 40 | 10 | HSF | 60 | 5 | 50 | 45 | 10 | 0.2 | 10% | 0.0 | Harvest |
| 8 | silt-loam | PG | 60 | 60 | 1175 | 40 | 10 | HSF | 60 | 5 | 25 | 45 | 10 | 0.2 | 10% | 0.0 | Harvest |
| 9 | silt-loam | PG | 60 | 60 | 1195 | 40 | 10 | HSF | 60 | 5 | 5 | 45 | 10 | 0.1 | 10% | 0.0 | Harvest |

Wildfire Skid Trail Scenario (Loam)

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Loam | ST | 35 | 35 | 695 | 10 | 10 | HSF | 35 | 5 | 5 | 45 | 10 | 1.3 | 57% | 0.1 | No Trail |
| 2 | Loam | ST | 35 | 35 | 675 | 10 | 10 | HSF | 35 | 5 | 25 | 45 | 10 | 1.2 | 57% | 0.1 | No Trail |
| 3 | Loam | ST | 35 | 35 | 650 | 10 | 10 | HSF | 35 | 5 | 50 | 45 | 10 | 1.2 | 53% | 0.1 | No Trail |
| 4 | Loam | ST | 35 | 35 | 625 | 10 | 10 | HSF | 35 | 5 | 75 | 45 | 10 | 1.2 | 53% | 0.1 | No Trail |
| 5 | Loam | ST | 35 | 35 | 600 | 10 | 10 | HSF | 35 | 5 | 100 | 45 | 10 | 1.1 | 50% | 0.1 | No Trail |
| 6 | Loam | ST | 35 | 35 | 575 | 10 | 10 | HSF | 35 | 5 | 125 | 45 | 10 | 1.1 | 43% | 0.1 | No Trail |
| 7 | Loam | ST | 35 | 35 | 550 | 10 | 10 | HSF | 35 | 5 | 150 | 45 | 10 | 1.1 | 43% | 0.1 | No Trail |
| 8 | Loam | ST | 35 | 35 | 525 | 10 | 10 | HSF | 35 | 5 | 175 | 45 | 10 | 1.9 | 43% | 0.1 | No Trail |
| 9 | Loam | ST | 35 | 35 | 500 | 10 | 10 | HSF | 35 | 5 | 200 | 45 | 10 | 1.1 | 40% | 0.1 | No Trail |
| 10 | Loam | ST | 35 | 35 | 475 | 10 | 10 | HSF | 35 | 5 | 225 | 45 | 10 | 0.9 | 37% | 0.1 | No Trail |
| 11 | Loam | ST | 35 | 35 | 450 | 10 | 10 | HSF | 35 | 5 | 250 | 45 | 10 | 0.9 | 37% | 0.1 | No Trail |
| 12 | Loam | ST | 35 | 35 | 425 | 10 | 10 | HSF | 35 | 5 | 275 | 45 | 10 | 0.8 | 33% | 0.1 | No Trail |
| 13 | Loam | ST | 35 | 35 | 400 | 10 | 10 | HSF | 35 | 5 | 300 | 45 | 10 | 0.7 | 33% | 0.1 | No Trail |
| 14 | Loam | ST | 35 | 35 | 375 | 10 | 10 | HSF | 35 | 5 | 325 | 45 | 10 | 0.6 | 33% | 0.1 | No Trail |
| 15 | Loam | ST | 35 | 35 | 350 | 10 | 10 | HSF | 35 | 5 | 350 | 45 | 10 | 0.5 | 30% | 0.0 | No Trail |
| 16 | Loam | ST | 35 | 35 | 325 | 10 | 10 | HSF | 35 | 5 | 375 | 45 | 10 | 0.4 | 30% | 0.0 | No Trail |
| 17 | Loam | ST | 35 | 35 | 300 | 10 | 10 | HSF | 35 | 5 | 400 | 45 | 10 | 0.2 | 23% | 0.0 | Trail |

Wildfire Skid Trail Scenario (Silt Loam)

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | silt-loam | ST | 35 | 35 | 695 | 10 | 10 | HSF | 35 | 5 | 5 | 45 | 10 | 1.7 | 40% | 0.1 | No Trail |
| 2 | silt-loam | ST | 35 | 35 | 675 | 10 | 10 | HSF | 35 | 5 | 25 | 45 | 10 | 1.6 | 30% | 0.1 | No Trail |
| 3 | silt-loam | ST | 35 | 35 | 650 | 10 | 10 | HSF | 35 | 5 | 50 | 45 | 10 | 1.6 | 30% | 0.1 | No Trail |
| 4 | silt-loam | ST | 35 | 35 | 625 | 10 | 10 | HSF | 35 | 5 | 75 | 45 | 10 | 1.5 | 30% | 0.1 | No Trail |
| 5 | silt-loam | ST | 35 | 35 | 600 | 10 | 10 | HSF | 35 | 5 | 100 | 45 | 10 | 1.5 | 27% | 0.1 | No Trail |
| 6 | silt-loam | ST | 35 | 35 | 575 | 10 | 10 | HSF | 35 | 5 | 125 | 45 | 10 | 1.4 | 27% | 0.1 | No Trail |
| 7 | silt-loam | ST | 35 | 35 | 550 | 10 | 10 | HSF | 35 | 5 | 150 | 45 | 10 | 1.3 | 27% | 0.1 | No Trail |
| 8 | silt-loam | ST | 35 | 35 | 525 | 10 | 10 | HSF | 35 | 5 | 175 | 45 | 10 | 1.2 | 27% | 0.1 | No Trail |
| 9 | silt-loam | ST | 35 | 35 | 500 | 10 | 10 | HSF | 35 | 5 | 200 | 45 | 10 | 0.9 | 27% | 0.1 | No Trail |
| 10 | silt-loam | ST | 35 | 35 | 475 | 10 | 10 | HSF | 35 | 5 | 225 | 45 | 10 | 0.8 | 27% | 0.0 | No Trail |
| 11 | silt-loam | ST | 35 | 35 | 450 | 10 | 10 | HSF | 35 | 5 | 250 | 45 | 10 | 0.7 | 27% | 0.0 | No Trail |

| WEPP Run Combo | Soil Texture | Upper Element = Treatment [6] | Upper Gradient (%) 1 | Upper Gradient (%) 2 | Upper Horizontal Length (ft.) | Upper Cover (%) | Upper Rock (%) | Lower Element = Buffer [6] | Lower Gradient (%) 1 | Lower Gradient (%) 2 | Lower Horizontal Length (ft.) | Lower Cover (%) | Lower Rock (%) | Delivery (30 years) t/ac | Probability of delivery | Delivery Average t/ac | Activity Cleared [7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | silt-loam | ST | 35 | 35 | 425 | 10 | 10 | HSF | 35 | 5 | 275 | 45 | 10 | 0.7 | 27% | 0.0 | No Trail |
| 13 | silt-loam | ST | 35 | 35 | 400 | 10 | 10 | HSF | 35 | 5 | 300 | 45 | 10 | 0.6 | 27% | 0.4 | No Trail |
| 14 | silt-loam | ST | 35 | 35 | 375 | 10 | 10 | HSF | 35 | 5 | 325 | 45 | 10 | 0.6 | 27% | 0.0 | No Trail |
| 15 | silt-loam | ST | 35 | 35 | 350 | 10 | 10 | HSF | 35 | 5 | 350 | 45 | 10 | 0.5 | 23% | 0.0 | No Trail |
| 16 | silt-loam | ST | 35 | 35 | 325 | 10 | 10 | HSF | 35 | 5 | 375 | 45 | 10 | 0.5 | 20% | 0.0 | Trail |

**Table 13 Proposed activities estimated DSC and calculated cumulative DSC[8]. See footnotes for activity codes used in table**

| Unit | Harvest System Proposed | Proposed Acres | Harvest System Proposed | Proposed Acres | Harvest System Proposed | Proposed Acres | Harvest System Proposed | Proposed Acres | Observed DSC Acres | Expected DSC=Harvest System DSC%* Unit Acres | | | | Expected Cumulative DSC Acres=Observed DSC+ Expected DSC | | | | Expected Cumulative DSC Percent=Observed DSC+ Expected DSC | | | | Unit < 20% DSC (Pass or Fail) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alt B | | Alt C | | Alt D | | Alt E | | Alt A | Alt B | Alt C | Alt D | Alt E | Alt B | Alt C | Alt D | Alt E | Alt B | Alt C | Alt D | Alt E | Alt B | Alt C | Alt D | Alt E |
| **2** | GBT | 9 | GBT | 9 | GBT | 9 | GBT | 9 | 0.0 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 13.0% | 13.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **2L** | | 0 | | 0 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **5** | GBT | 20 | GBT | 20 | GBT | 20 | GBT | 20 | 0.0 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 13.0% | 13.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **5L** | | 0 | | 0 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **6** | GBT | 13 | GBT | 13 | GBT | 13 | GBT | 13 | 0.0 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 13.3% | 13.3% | 13.3% | 13.3% | Pass | Pass | Pass | Pass |
| **6L** | | 0 | | 0 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **7** | GBT | 26 | GBT | 26 | GBT | 26 | GBT | 26 | 0.0 | 3.4 | 3.4 | 3.4 | 3.4 | 3.5 | 3.5 | 3.5 | 3.5 | 13.2% | 13.2% | 13.2% | 13.2% | Pass | Pass | Pass | Pass |
| **7L** | | 0 | GBT | 13 | | 0 | | 0 | 0.0 | 0.0 | 1.7 | 0.0 | 0.0 | 0.0 | 1.7 | 0.0 | 0.0 | 0.0% | 13.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **8** | GBT | 57 | GBT | 57 | GBT | 57 | GBT | 57 | 0.3 | 7.8 | 7.8 | 7.8 | 7.8 | 8.1 | 8.1 | 8.1 | 8.1 | 14.1% | 14.1% | 14.1% | 14.1% | Pass | Pass | Pass | Pass |
| **8L** | | 0 | | 0 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **9** | GBF | 48 | GBF | 48 | GBF | 48 | GBF | 48 | 2.0 | 7.4 | 7.4 | 7.4 | 7.4 | 9.4 | 9.4 | 9.4 | 9.4 | 19.5% | 19.5% | 19.5% | 19.5% | Pass | Pass | Pass | Pass |
| **9L** | | 0 | GBF | 15 | | 0 | | 0 | 0.0 | 0.0 | 1.6 | 0.0 | 0.0 | 0.0 | 1.6 | 0.0 | 0.0 | 0.0% | 11.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **10** | GBT | 31 | GBT | 31 | GBT | 31 | GBT | 31 | 0.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 13.0% | 13.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **10L** | | 0 | GBT | 11 | | 0 | | 0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 | 0.0% | 13.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **11** | GBT | 32 | GBT | 32 | GBT | 32 | GBT | 32 | 0.0 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 13.0% | 13.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **11** | Sky | 32 | Sky | 32 | Sky | 32 | Sky | 32 | 0.0 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 5.0% | 5.0% | 5.0% | 5.0% | Pass | Pass | Pass | Pass |
| **11L** | | 0 | | 0 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **13** | GBF | 53 | GBF | 53 | GBF | 53 | GBF | 53 | 0.0 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 11.0% | 11.0% | 11.0% | 11.0% | Pass | Pass | Pass | Pass |
| **13L** | | 0 | GBF | 17 | | 0 | | 0 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 | 0.0% | 11.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |

[8] Detrimental estimates are based on previous monitoring of various harvest systems, Harvest Method Code: Ha=Hand (0% DCS), GBT= Ground Based Tractor (13% DSC), GBF=Ground Based Forwarder (11% DSC), Sky=Skyline (5% DSC), He=Helicopter (2% DSC), NCT=Non-Commercial Thin (1% DSC). Each of these DSC estimates has a different effective duration on the landscape.

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **14** | GBF | 73 | GBF | 73 | GBF | 73 | GBF | 73 | 0.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 11.0% | 11.0% | 11.0% | 11.0% | Pass | Pass | Pass | Pass |
| **14L** | | 0 | | 0 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **15** | | 0 | | 0 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **15A** | GBT | 13 | | 0 | GBT | 13 | GBT | 13 | 0.0 | 1.7 | 0.0 | 1.7 | 1.7 | 1.7 | 0.0 | 1.7 | 1.7 | 13.0% | 0.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **15B** | GBT | 11 | | 0 | | 0 | GBT | 11 | 0.0 | 1.4 | 0.0 | 0.0 | 1.4 | 1.4 | 0.0 | 0.0 | 1.4 | 13.0% | 0.0% | 0.0% | 13.0% | Pass | Pass | Pass | Pass |
| **16A** | GBT | 20 | GBT | 20 | | 0 | GBT | 20 | 0.4 | 3.0 | 3.0 | 0.0 | 3.0 | 3.4 | 3.4 | 0.4 | 3.4 | 16.9% | 16.9% | 0.0% | 16.9% | Pass | Pass | Pass | Pass |
| **16B** | GBT | 10 | | 0 | | 0 | GBT | 10 | 0.2 | 1.5 | 0.0 | 0.0 | 1.5 | 1.6 | 0.2 | 0.2 | 1.6 | 16.2% | 0.0% | 0.0% | 16.2% | Pass | Pass | Pass | Pass |
| **16L** | | 0 | GBT | 11 | | 0 | | 0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 | 0.0% | 13.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **17** | GBT | 21 | GBT | 21 | GBT | 21 | GBT | 21 | 0.0 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 13.0% | 13.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **17L** | | 0 | GBT | 14 | | 0 | | 0 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 | 0.0% | 13.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **18** | GBF | 11 | GBF | 11 | GBF | 11 | GBF | 11 | 0.0 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 11.0% | 11.0% | 11.0% | 11.0% | Pass | Pass | Pass | Pass |
| **19** | GBF | 18 | GBF | 18 | GBF | 18 | GBF | 18 | 0.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 11.5% | 11.5% | 11.5% | 11.5% | Pass | Pass | Pass | Pass |
| **19L** | | 0 | GBF | 11 | | 0 | | 0 | 0.0 | 0.0 | 1.2 | 0.0 | 0.0 | 0.0 | 1.2 | 0.0 | 0.0 | 0.0% | 11.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **20** | Sky | 9 | Sky | 9 | | 0 | Sky | 9 | 0.0 | 0.5 | 0.5 | 0.0 | 0.5 | 0.6 | 0.6 | 0.0 | 0.6 | 5.9% | 5.9% | 0.0% | 5.9% | Pass | Pass | Pass | Pass |
| **20L** | | 0 | | 0 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **21** | Ha | 15 | Ha | 15 | Ha | 15 | Ha | 15 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 1.2% | 1.2% | 1.2% | 1.2% | Pass | Pass | Pass | Pass |
| **22** | GBT | 20 | GBT | 20 | GBT | 20 | GBT | 20 | 0.0 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 13.0% | 13.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **24** | Ha | 6 | Ha | 6 | | 0 | Ha | 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **25** | Ha | 16 | Ha | 16 | | 0 | Ha | 16 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **26** | Sky | 15 | Sky | 15 | Sky | 15 | Sky | 15 | 0.3 | 1.0 | 1.0 | 1.0 | 1.0 | 1.3 | 1.3 | 1.3 | 1.3 | 8.6% | 8.6% | 8.6% | 8.6% | Pass | Pass | Pass | Pass |
| **27** | Ha | 8 | Ha | 8 | Ha | 8 | Ha | 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **28** | Ha | 7 | Ha | 7 | Ha | 7 | Ha | 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **29** | Ha | 6 | Ha | 6 | Ha | 6 | Ha | 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **30*** | Sky | 24 | Sky | 24 | GBF | 24 | GBF | 24 | 0.4 | 1.6 | 1.6 | 3.1 | 3.1 | 2.0 | 2.0 | 3.5 | 3.5 | 8.3% | 8.3% | 14.3% | 14.3% | Pass | Pass | Pass | Pass |
| **31** | Sky | 11 | Sky | 11 | Sky | 11 | Sky | 11 | 0.3 | 0.9 | 0.9 | 0.9 | 0.9 | 1.2 | 1.2 | 1.2 | 1.2 | 11.2% | 11.2% | 11.2% | 11.2% | Pass | Pass | Pass | Pass |
| **34** | GBT | 17 | GBT | 17 | GBT | 17 | GBT | 17 | 0.0 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 13.0% | 13.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **34L** | | 0 | GBT | 10 | | 0 | | 0 | 0.0 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0% | 13.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **35** | Ha | 22 | Ha | 22 | Ha | 22 | Ha | 22 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **37** | GBF | 26 | GBF | 26 | GBF | 26 | GBF | 26 | 0.0 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 11.0% | 11.0% | 11.0% | 11.0% | Pass | Pass | Pass | Pass |
| **37L** | | 0 | | 11 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **38** | Ha | 20 | Ha | 20 | Ha | 20 | Ha | 20 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **39** | GBT | 14 | | 0 | GBT | 14 | GBT | 14 | 0.0 | 1.8 | 0.0 | 1.8 | 1.8 | 1.8 | 0.0 | 1.8 | 1.8 | 13.0% | 0.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **40** | GBF | 43 | GBF | 43 | GBF | 43 | GBF | 43 | 1.5 | 6.2 | 6.2 | 6.2 | 6.2 | 7.7 | 7.7 | 7.7 | 7.7 | 17.9% | 17.9% | 17.9% | 17.9% | Pass | Pass | Pass | Pass |
| **40L** | | 0 | | 0 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **41A** | Sky | 18 | | 0 | | 0 | Sky | 18 | 0.3 | 1.2 | 0.0 | 0.0 | 1.2 | 1.5 | 0.3 | 0.3 | 1.5 | 8.5% | 0.0% | 0.0% | 8.5% | Pass | Pass | Pass | Pass |
| **41B** | Sky | 7 | | 0 | | 0 | Sky | 7 | 0.1 | 0.4 | 0.0 | 0.0 | 0.4 | 0.5 | 0.1 | 0.1 | 0.5 | 7.1% | 0.0% | 0.0% | 7.1% | Pass | Pass | Pass | Pass |
| **42** | GBT | 29 | GBT | 29 | GBT | 29 | GBT | 29 | 0.0 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 13.0% | 13.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **42L** | | 0 | GBT | 12 | | 0 | | 0 | 0.0 | 0.0 | 1.5 | 0.0 | 0.0 | 0.0 | 1.5 | 0.0 | 0.0 | 0.0% | 13.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **43** | GBF | 24 | GBF | 24 | GBF | 24 | GBF | 24 | 0.2 | 2.8 | 2.8 | 2.8 | 2.8 | 3.1 | 3.1 | 3.1 | 3.1 | 12.9% | 12.9% | 12.9% | 12.9% | Pass | Pass | Pass | Pass |
| **43L** | | 0 | | 13 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **44** | GBF | 21 | GBF | 21 | GBF | 21 | GBF | 21 | 0.0 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 11.0% | 11.0% | 11.0% | 11.0% | Pass | Pass | Pass | Pass |
| **44L** | | 0 | GBF | 13 | | 0 | | 0 | 0.0 | 0.0 | 1.5 | 0.0 | 0.0 | 0.0 | 1.5 | 0.0 | 0.0 | 0.0% | 11.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **45** | Sky | 16 | Sky | 16 | | 0 | Sky | 16 | 0.0 | 0.8 | 0.8 | 0.0 | 0.8 | 0.8 | 0.8 | 0.0 | 0.8 | 5.0% | 5.0% | 0.0% | 5.0% | Pass | Pass | Pass | Pass |
| **45L** | | 0 | Sky | 10 | | 0 | | 0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0% | 5.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **46** | GBF | 11 | GBF | 11 | GBF | 11 | GBF | 11 | 0.3 | 1.5 | 1.5 | 1.5 | 1.5 | 1.8 | 1.8 | 1.8 | 1.8 | 16.6% | 16.6% | 16.6% | 16.6% | Pass | Pass | Pass | Pass |
| **47** | GBT | 61 | GBT | 61 | GBT | 61 | GBT | 61 | 1.0 | 9.0 | 9.0 | 9.0 | 9.0 | 10.0 | 10.0 | 10.0 | 10.0 | 16.3% | 16.3% | 16.3% | 16.3% | Pass | Pass | Pass | Pass |
| **49** | GBF | 20 | GBF | 20 | GBF | 20 | GBF | 20 | 0.0 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 | 11.1% | 11.1% | 11.1% | 11.1% | Pass | Pass | Pass | Pass |
| **50** | GBF | 26 | GBF | 26 | GBF | 26 | GBF | 26 | 0.2 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 11.7% | 11.7% | 11.7% | 11.7% | Pass | Pass | Pass | Pass |
| **51** | GBT | 31 | GBT | 31 | Ha | 31 | GBT | 31 | 0.4 | 4.4 | 4.4 | 0.4 | 4.4 | 4.4 | 4.4 | 0.4 | 4.4 | 14.3% | 14.3% | 1.3% | 14.3% | Pass | Pass | Pass | Pass |
| **52** | GBT | 49 | GBT | 49 | Ha | 49 | GBT | 49 | 0.3 | 6.7 | 6.7 | 0.3 | 6.7 | 6.7 | 6.7 | 0.3 | 6.7 | 13.6% | 13.6% | 0.6% | 13.6% | Pass | Pass | Pass | Pass |
| **53** | Ha | 7 | Ha | 7 | Ha | 7 | Ha | 7 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 3.6% | 3.6% | 3.6% | 3.6% | Pass | Pass | Pass | Pass |
| **54** | Ha | 5 | Ha | 5 | Ha | 5 | Ha | 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **55** | GBT | 15 | GBT | 15 | | 0 | GBT | 15 | 0.0 | 2.0 | 2.0 | 0.0 | 2.0 | 2.0 | 2.0 | 0.0 | 2.0 | 13.0% | 13.0% | 0.0% | 13.0% | Pass | Pass | Pass | Pass |
| **55L** | | 0 | Ha | 8 | | 0 | | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **56** | Ha | 14 | Ha | 14 | Ha | 14 | Ha | 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **57** | Ha | 28 | Ha | 28 | Ha | 28 | Ha | 28 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **58** | GBT | 18 | GBT | 18 | Ha | 18 | Ha | 18 | 0.0 | 2.4 | 2.4 | 0.0 | 0.0 | 2.4 | 2.4 | 0.0 | 0.0 | 13.0% | 13.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **60** | GBT | 6 | GBT | 6 | GBT | 6 | GBT | 6 | 0.2 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 16.4% | 16.4% | 16.4% | 16.4% | Pass | Pass | Pass | Pass |
| **61** | Ha | 76 | Ha | 76 | Ha | 76 | Ha | 76 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **66** | Ha | 6 | Ha | 6 | Ha | 6 | Ha | 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |

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| **67** | Ha | 17 | Ha | 17 | Ha | 17 | Ha | 17 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **70** | Ha | 37 | Ha | 37 | Ha | 37 | Ha | 37 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **73** | Ha | 29 | Ha | 29 | Ha | 29 | Ha | 29 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **75** | Ha | 39 | Ha | 39 | Ha | 39 | Ha | 39 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5% | 0.5% | 0.5% | 0.5% | Pass | Pass | Pass | Pass |
| **76** | Ha | 45 | Ha | 45 | Ha | 45 | Ha | 45 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **78** | Ha | 15 | Ha | 15 | Ha | 15 | Ha | 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **80** | Ha | 17 | Ha | 17 | Ha | 17 | Ha | 17 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **82** | Ha | 32 | Ha | 32 | Ha | 32 | Ha | 32 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **84** | Ha | 16 | Ha | 16 | Ha | 16 | Ha | 16 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **85** | Ha | 15 | Ha | 15 | Ha | 15 | Ha | 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **86** | Ha | 5 | Ha | 5 | Ha | 5 | Ha | 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **87** | Ha | 13 | Ha | 12 | Ha | 13 | Ha | 13 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **89** | Ha | 12 | Ha | 9 | Ha | 12 | Ha | 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **91** | Ha | 16 | Ha | 16 | Ha | 16 | Ha | 16 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **92** | GBT | 117 | GBT | 111 | Ha | 117 | GBT | 117 | 0.0 | 15.2 | 14.4 | 0.0 | 15.2 | 15.2 | 14.4 | 0.0 | 15.2 | 13.0% | 13.0% | 0.0% | 13.0% | Pass | 92 | GBT | Pass |
| **94** | Ha | 34 | Ha | 34 | Ha | 34 | Ha | 34 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **95** | Ha | 28 | Ha | 28 | Ha | 28 | Ha | 28 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **96** | Ha | 31 | Ha | 31 | Ha | 31 | Ha | 31 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **97** | Ha | 20 | Ha | 20 | Ha | 20 | Ha | 20 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **98** | Ha | 23 | Ha | 23 | Ha | 23 | Ha | 23 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **99** | Ha | 33 | Ha | 33 | Ha | 33 | Ha | 33 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **100** | Ha | 27 | Ha | 27 | Ha | 27 | Ha | 27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **101** | Ha | 31 | Ha | 31 | Ha | 31 | Ha | 31 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **102** | Ha | 33 | Ha | 33 | Ha | 33 | Ha | 33 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **103** | Ha | 31 | Ha | 31 | Ha | 31 | Ha | 31 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **104** | Ha | 38 | Ha | 38 | Ha | 38 | Ha | 38 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **105** | Ha | 27 | Ha | 27 | Ha | 27 | Ha | 27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **106** | Ha | 36 | Ha | 36 | Ha | 36 | Ha | 36 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **107** | Ha | 32 | Ha | 32 | Ha | 32 | Ha | 32 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **108** | Ha | 20 | Ha | 20 | Ha | 20 | Ha | 20 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |

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| **111** | Ha | 27 | Ha | 27 | Ha | 27 | Ha | 27 | 1.1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 4.5% | 4.5% | 4.5% | 4.5% | Pass | Pass | Pass | Pass |
| **112** | Ha | 20 | Ha | 20 | Ha | 20 | Ha | 20 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **113** | Ha | 27 | Ha | 27 | Ha | 27 | Ha | 27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **114** | Ha | 11 | Ha | 11 | Ha | 11 | Ha | 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **115** | Ha | 21 | Ha | 20 | Ha | 21 | Ha | 21 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 1.1% | 1.1% | 1.1% | 1.1% | Pass | Pass | Pass | Pass |
| **116** | Ha | 18 | Ha | 18 | Ha | 18 | Ha | 18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **117** | Ha | 7 | Ha | 7 | Ha | 7 | Ha | 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **118** | Ha | 4 | Ha | 4 | Ha | 4 | Ha | 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **119** | Ha | 6 | Ha | 6 | Ha | 6 | Ha | 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **120** | Ha | 11 | Ha | 11 | Ha | 11 | Ha | 11 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 2.5% | 2.5% | 2.5% | 2.5% | Pass | Pass | Pass | Pass |
| **121** | Ha | 6 | Ha | 6 | Ha | 6 | Ha | 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **122** | Ha | 12 | Ha | 12 | Ha | 12 | Ha | 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **123** | Ha | 27 | Ha | 27 | Ha | 27 | Ha | 27 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 2.3% | 2.3% | 2.3% | 2.3% | Pass | Pass | Pass | Pass |
| **124** | Ha | 5 | Ha | 5 | Ha | 5 | Ha | 5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 1.6% | 1.7% | 1.6% | 1.6% | Pass | Pass | Pass | Pass |
| **125** | Ha | 28 | Ha | 28 | Ha | 28 | Ha | 28 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.6% | 0.6% | 0.6% | 0.6% | Pass | Pass | Pass | Pass |
| **126** | Ha | 20 | Ha | 20 | Ha | 20 | Ha | 20 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **129A** | GBT | 73 | GBT | 73 | GBT | 73 | GBT | 73 | 0.0 | 9.5 | 9.5 | 9.5 | 9.5 | 9.5 | 9.5 | 9.5 | 9.5 | 13.0% | 13.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **129B** | Ha | 37 | Ha | 37 | Ha | 37 | Ha | 37 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% | 0.0% | Pass | Pass | Pass | Pass |
| **130** | GBT | 53 | GBT | 53 | GBT | 53 | GBT | 53 | 0.0 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 6.8 | 13.0% | 13.0% | 13.0% | 13.0% | Pass | Pass | Pass | Pass |
| **131** | | 0 | | 0 | | 0 | Sky | 18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 | 0.9 | 0.0% | 0.0% | 0.0% | 5.0% | Pass | Pass | Pass | Pass |
| **132** | | 0 | | 0 | | 0 | Sky | 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0% | 0.0% | 0.0% | 5.0% | Pass | Pass | Pass | Pass |
| **133** | | 0 | | 0 | | 0 | Sky | 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0% | 0.0% | 0.0% | 5.0% | Pass | Pass | Pass | Pass |
| **134** | | 0 | | 0 | | 0 | Sky | 13 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0% | 0.0% | 0.0% | 5.0% | Pass | Pass | Pass | Pass |
| **135** | | 0 | | 0 | | 0 | Sky | 23 | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 0.0 | 0.0 | 0.0 | 1.2 | 0.0% | 0.0% | 0.0% | 5.0% | Pass | Pass | Pass | Pass |
| **136** | | 0 | | 0 | | 0 | GBF | 19 | 0.0 | 0.0 | 0.0 | 0.0 | 2.1 | 0.0 | 0.0 | 0.0 | 2.1 | 0.0% | 0.0% | 0.0% | 11.0% | Pass | Pass | Pass | Pass |
| **137** | | 0 | | 0 | | 0 | GBF | 35 | 0.6 | 0.0 | 0.0 | 0.0 | 4.4 | 0.0 | 0.0 | 0.0 | 4.4 | 0.0% | 0.0% | 0.0% | 12.8% | Pass | Pass | Pass | Pass |
| **138** | | 0 | | 0 | | 0 | Sky | 22 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0% | 0.0% | 0.0% | 5.0% | Pass | Pass | Pass | Pass |
| **139** | | 0 | | 0 | | 0 | GBT | 11 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0% | 0.0% | 0.0% | 13.0% | Pass | Pass | Pass | Pass |
| **140** | | 0 | | 0 | | 0 | GBT | 11 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0% | 0.0% | 0.0% | 13.0% | Pass | Pass | Pass | Pass |
| **141** | | 0 | | 0 | | 0 | GBT | 28 | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | 0.0 | 0.0 | 0.0 | 3.6 | 0.0% | 0.0% | 0.0% | 13.0% | Pass | Pass | Pass | Pass |

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| **142** | | 0 | | 0 | | 0 | GBF | 64 | 0.0 | 0.0 | 0.0 | 0.0 | 7.0 | 0.0 | 0.0 | 0.0 | 7.0 | 0.0% | 0.0% | 0.0% | 11.0% | Pass | Pass | Pass | Pass |
| **143** | | 0 | | 0 | | 0 | GBT | 10 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0% | 0.0% | 0.0% | 13.0% | Pass | Pass | Pass | Pass |
| **144** | | 0 | | 0 | | 0 | GBF | 17 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 | 0.0 | 1.8 | 0.0% | 0.0% | 0.0% | 11.0% | Pass | Pass | Pass | Pass |
| **145** | | 0 | | 0 | | 0 | GBF | 38 | 0.0 | 0.0 | 0.0 | 0.0 | 4.1 | 0.0 | 0.0 | 0.0 | 4.1 | 0.0% | 0.0% | 0.0% | 11.0% | Pass | Pass | Pass | Pass |
| **146** | | 0 | | 0 | | 0 | Sky | 10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0% | 0.0% | 0.0% | 5.0% | Pass | Pass | Pass | Pass |
| **147** | | 0 | | 0 | | 0 | Sky | 10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0% | 0.0% | 0.0% | 5.0% | Pass | Pass | Pass | Pass |
| **148** | | 0 | | 0 | | 0 | Sky | 22 | 0.3 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0% | 0.0% | 0.0% | 6.4% | Pass | Pass | Pass | Pass |
| **149** | | 0 | | 0 | | 0 | GBF | 26 | 0.0 | 0.0 | 0.0 | 0.0 | 2.8 | 0.0 | 0.0 | 0.0 | 2.8 | 0.0% | 0.0% | 0.0% | 11.0% | Pass | Pass | Pass | Pass |
| **150** | | 0 | | 0 | | 0 | GBT | 35 | 0.0 | 0.0 | 0.0 | 0.0 | 4.5 | 0.0 | 0.0 | 0.0 | 4.5 | 0.0% | 0.0% | 0.0% | 13.0% | Pass | Pass | Pass | Pass |
| **151** | | 0 | | 0 | | 0 | GBT | 23 | 0.0 | 0.0 | 0.0 | 0.0 | 3.0 | 0.0 | 0.0 | 0.0 | 3.0 | 0.0% | 0.0% | 0.0% | 13.0% | Pass | Pass | Pass | Pass |
| **152** | | 0 | | 0 | | 0 | Sky | 17 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.8 | 0.0% | 0.0% | 0.0% | 5.0% | Pass | Pass | Pass | Pass |
| **153** | | 0 | | 0 | | 0 | GBT | 46 | 0.0 | 0.0 | 0.0 | 0.0 | 6.0 | 0.0 | 0.0 | 0.0 | 6.0 | 0.0% | 0.0% | 0.0% | 13.0% | Pass | Pass | Pass | Pass |
| Total | | 2545.6 | | 2773.8 | | 2417.2 | | 3068.1 | 12.2 | 158.7 | 165.9 | 121.5 | 209.8 | 166.3 | 173.4 | 129.1 | 217.4 | 6.5% | 6.3% | 4.2% | 7.1% | Pass | Pass | Pass | Pass |